Engineering Library

The Engineer.

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The Engineer

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PUBLIC NOTICES

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E.1, invites TENDERS for :—
SCHEDULE 1.—6 SETS CYLINDERS, MOTION DETAILS, &c., for LOCOMOTIVES.
SCHEDULE 2.—70 CAMBER JACKS for BRIDGES.
Tenders due as follows :—
Schedule 1, 2nd April, 1930.
Schedule 2, 4th April, 1930.
Forms of Tender available from the above at a fee (which will not be returned) of 5s. for each schedule. 4623

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.
APPLICATIONS from qualified candidates are INVITED for the following POSTS :—
M/2015.—ASSISTANT ENGINEERS (8) REQUIRED by the GOVERNMENT OF NIGERIA for the PUBLIC WORKS DEPARTMENT, for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service, the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480 a year for the first three years ; then £510, rising by annual increments to £920. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates must have attained the age of 21½ years on the date of appointment, and should preferably have attained the age of 22½, and must not be over 35 years of age. Must have obtained an Engineering Degree at a recognised University or have passed Sections "A" and "B" of the A.M.I.C.E. Examination or have passed the Associateship in Civil Engineering of the City and Guilds Institute, or possess such other Degree or Diploma or Distinction in Engineering as may be considered satisfactory. Candidates whose qualifying diplomas have been obtained without a college course should have had three years' practical experience of Civil Engineering under a qualified Civil Engineer. It is preferred that all candidates should have had two years' practical experience on good engineering work, subsequent to taking their degree or completing their articles, but under certain conditions this may be waived in the case of candidates in possession of an Engineering Degree.
M/1986.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT OF TANGANYIKA TERRITORY for the PUBLIC WORKS DEPARTMENT for a tour of 20 to 30 months' service, with possible extension. Salary £480, rising to £600 a year by annual increments of £20, and thence rising to £720 a year by annual increments of £30. Free quarters and passages and outfit allowance of £30 on first appointment. Candidates, aged 25 to 30, unmarried, must have passed sections "A" and "B" of the A.M.I.C.E. Examination or hold professional qualifications recognised by the Institution of Civil Engineers as exempting from those examinations. Must be capable of Levelling, Surveying and Measuring Up Work, and, in addition, to Preparing Neat Drawings for the Design of Bridges, &c. Must have had at least three years' experience under a qualified Civil Engineer on the Construction of Railway Works, Drainage Works, Water Supply, or other Public Works.
M/1973.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT OF TRINIDAD for the PUBLIC WORKS DEPARTMENT, for three years' service, with possible extension, at a salary of £500, rising to £600 a year by annual increments of £25. Free passages. Candidates, 25 to 30 years of age, preferably unmarried, must have passed sections "A" and "B" of the examination for the A.M.I.C.E. Diploma, or hold professional qualifications recognised by the Institution of Civil Engineers as exempting from those examinations, and have had at least five years' practical experience upon Engineering Works of some magnitude, especially in the Construction and Maintenance of Roads and Bridges.
Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting the reference number against the appointment for which application is made. 4615

Factory Premises (KINGSWAY ENGINEERING WORKS), Clapington-road, Dundee, by PRIVATE TREATY ; main block (built 1925) consists of extensive Machine Hall, Administrative Offices, &c. Centrally heated, electric light, power and gas installations ; also other Factory Type Buildings, Stores, &c. Could be adapted for use as garage and workshop. Site area about 5 acres. May be inspected on application to the Caretaker on the premises.—Further particulars from DIRECTOR OF LANDS AND ACCOMMODATION, H.M. Office of Works, King Charles-street, London, S.W.1 ; of H.M. OFFICE OF WORKS, 122, George-street, Edinburgh. 4470

Administrative County of LONDON.
The London County Council requires a FULL-TIME TEACHER to Take Charge of the Part-time Day Classes for Engineering Apprentices and Youths in Training at the Tramways Repair Depot, Charlton. The classes are under the supervision of the Principal of the School of Engineering and Navigation, Poplar, and the teacher appointed will be a full-time member of the staff of that school. Candidates should be graduates in Engineering and be prepared to take classes in Engineering Science, Drawing, and Mathematics, together with some English. Works experience will be a recommendation, and, if after the age of 21 years, will count towards assessment of commencing rate of salary. Graduate scale—£276, rising by annual increments of £15 to £528. In addition to the salary scale a special responsibility allowance may be paid. The first increment accrues after two years' teaching service.
Apply, Education Officer (T. 1.), The County Hall, Westminster Bridge, S.E.1 (stamped addressed foolscape envelope necessary), for form, to be returned by 31st March. Canvassing disqualifies.
MONTAGU H. COX,
4607 Clerk of the London County Council.

University College of Swansea.
The Council invites APPLICATIONS for the POST of LECTURER in METALLURGY. Salary £500 per annum. The appointment will date from the 24th April, 1930, or later by arrangement.
Further particulars may be obtained from the undersigned, by whom applications must be received on or before Friday, March 28th, 1930.
EDWIN DREW,
Registrar.
Singleton Park, Swansea. 4552

PUBLIC NOTICES

Lancashire Education Committee.
ASHTON-UNDER-LYNE JUNIOR TECHNICAL SCHOOL.
WANTED, an ASSISTANT MASTER, Graduate in Engineering, with works experience, capable of taking Pure Science. The master appointed will be expected to take an active part in the corporate life of the school.
Further particulars and forms of application, which should be returned by 29th March, 1930, may be obtained on receipt of stamped addressed foolscap envelope, from the undersigned.
G. W. HANDFORTH.
Education Offices,
8, Warrington-street,
Ashton-under-Lyne. 4595

Coventry Corporation.
TENDERS FOR PUMPING MACHINERY.
The Corporation of Coventry are prepared to receive TENDERS from responsible British manufacturers only for the MANUFACTURE and ERECTION of Electrically Driven PUMPING MACHINERY for their Pumping Station at Whitley, Coventry.
There are to be two sets of pumps, each consisting of one bore-hole or well pump and one high-lift or force pump, both driven through one vertical spindle by the same motor ; with valves, castings, and other accessories. Each pump is to be capable of delivering 1 million gallons of water in 24 hours against the heads specified.
The drawing may be seen and the conditions of contract, specification, schedule of prices, instructions to persons tendering, and form of Tender obtained, on and after Wednesday, the 19th of March, until Noon on Wednesday, the 2nd of April, 1930, at the offices of the Engineers, Sir Alex. Binnie, Son and Deacon, Artillery House, Artillery-row, Westminster, S.W.1, on payment of a cheque for £10 made out to the Corporation of Coventry, which amount will be returned on receipt of a bona fide Tender.
Sealed Tenders, endorsed "Tender for Whitley Pumping Machinery," should be delivered at my office at or before Noon on Monday, the 14th of April, 1930.
The lowest or any Tender will not necessarily be accepted nor will any expenses in connection with tendering be defrayed, nor Tenders for machinery not of British manufacture be examined. Tender forms will not be issued after Noon on Wednesday, the 2nd of April, 1930. The Tenders sent in must be accompanied by the schedules fully filled in.
FREDERICK SMITH,
Town Clerk, Coventry.
Council House, Coventry, 4596

PUBLIC NOTICES

Isle of Man Harbours.
TO DREDGING CONTRACTORS.
The Isle of Man Harbour Commissioners are prepared to receive TENDERS for Certain DREDGING (about 8200 cubic yards of rock and 67,000 cubic yards of softer material), to be done in the Outer Harbour at Douglas, Isle of Man.
Copies of the specification, form of Tender, and drawings may be obtained from W. H. Blaker, Esq., M.I.C.E., the Engineer to the Commissioners, at the undermentioned address on payment of £3 3s., which will be returned on receipt of a bona fide Tender.
Tenders, endorsed "Douglas Dredging," must be in the hands of the undermentioned not later than Tuesday, March 25th, 1930.
The Commissioners do not bind themselves to accept the lowest or any Tender.
By Order,
A. W. TONGUE,
Secretary.
Harbour Commissioners' Offices,
Douglas, Isle of Man,
March 7th, 1930. 4592

The Bengal and North-Western RAILWAY COMPANY, LIMITED.
The Directors are prepared to receive TENDERS for the SUPPLY of :—
12 LOCOMOTIVE BOILERS and CYLINDERS, &c.,
as per specification to be seen at the Company's offices.
Tenders, addressed to the undersigned, and marked "Tender for Boilers, &c.," with name of firm tendering, to be lodged not later than Noon on the 1st day of April, 1930.
For each specification a fee of £1 will be charged, which cannot under any circumstances be returned.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
W. R. IZAT,
Managing Director.
237, Gresham House, Old Broad-street,
London, E.C. 2, 12/3/1930. 4617

Well-known Manufacturers of MARINE SPECIALTIES (about 50 miles from London) wish to NEGOTIATE for the SUPPLY of all their IRON CASTINGS with a Firm of Founders who are able to turn out first-class work in quick time.
Replies are invited from firms capable of dealing with about 10/15 tons per week and familiar with Lloyd's, B.O.T. and Admiralty requirements.
Address, 4598, The Engineer Office 4598

PUBLIC NOTICES

The Committee of Management of the Benevolent Fund of the Institution of Civil Engineers HEREBY CONVENE an EXTRAORDINARY GENERAL MEETING of the CONTRIBUTORS to that Fund, to be held at The Institution, Great George-street, Westminster, S.W.1, at 4 p.m., on MONDAY, 24th MARCH, 1930, for the purpose of considering, and, if thought fit, of confirming the alterations in the Rules of the Fund, as submitted to and approved by the Contributors present at the Annual General Meeting. 4604

Manchester Corporation Water-Works.
HAWESWATER—CONTRACT B.
The Waterworks Committee invite TENDERS for the CONSTRUCTION of the NORTHERN SECTION of the HAWESWATER AQUEDUCT, comprising about 5½ miles of tunnel, 1½ miles of conduit, and 2 miles of large pipes.
Specification, schedule of quantities, form of Tender, and copies of the drawings may be obtained on application to the Engineer, Waterworks Offices, Town Hall, Manchester, on payment of a deposit of £10, which sum will only be refunded provided a bona fide Tender shall have been sent in, together with the documents and drawings lent, the latter of which must be unmarked.
Firms who have had no experience of the work herein referred to should not apply, as their Tenders would not be considered.
Sealed Tenders, endorsed as directed in the schedule, must be delivered at the Waterworks Offices, Town Hall, Manchester, not later than the 12th April, 1930.
By Order,
F. E. WARBRECK HOWELL,
Town Clerk.
Town Hall, Manchester,
6th March, 1930 4608

Stornoway Pier and Harbour COMMISSION.
HARBOUR IMPROVEMENTS AT STORNOWAY.
The Stornoway Pier and Harbour Commissioners are prepared to receive TENDERS for the CONSTRUCTION of REINFORCED CONCRETE WHARVES and RELATIVE WORKS.
Drawings and contract documents may be inspected on and after the 8th March, at the offices of the undersigned, and Henderson and Nicol, Chartered Civil Engineers, 21, Bridge-street, Aberdeen.
Copies of the contract documents and drawings may be obtained on and after 8th March from Messrs. Henderson and Nicol on payment of the charge of £2 2s., which will not be returnable.
Sealed Tenders, endorsed "Tender for Harbour Improvement Works," must be lodged with the undersigned not later than 11th April, 1930.
The Commissioners do not bind themselves to accept the lowest or any Tender.
ARCH. MUNRO,
Secretary.
Stornoway Pier and Harbour Commissioners.
Town Hall, Stornoway. 4593

Metropolitan Water Board.
APPOINTMENT OF A SENIOR ASSISTANT ENGINEER AND AN ASSISTANT ENGINEER.
The Metropolitan Water Board invite APPLICATIONS for the APPOINTMENT of ONE SENIOR ASSISTANT ENGINEER at a commencing salary of £550 per annum, rising by annual increments of £25 to £650 per annum ; and ONE ASSISTANT ENGINEER at a commencing salary of £425 per annum, rising by annual increments—the first four of £25, and the last of £15—to £540 per annum.
Candidates must have had considerable experience in the design and maintenance of important waterworks, including reservoirs, filtration and distribution works, and in the administration of waterworks undertakings.
Applicants must be Corporate Members of the Institution of Civil Engineers, and must have had responsible experience with the Water Department of a Public Authority or with a Water Company.
The successful applicants will be required to pass satisfactorily a medical examination by the Board's Chief Medical Officer, and to undertake to join the Board's Superannuation and Provident Fund.
The appointments will be held during the pleasure of the Board.
Applications, in candidates' own handwriting, stating age and particulars of experience, education, training, qualifications and academical degrees, and accompanied by copies of three recent testimonials, should be addressed, in envelopes endorsed "Senior Assistant Engineer" or "Assistant Engineer," as the case may be, to Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, and must reach the offices of the Board not later than the 27th March, 1930.
Canvassing will be held to be a disqualification.
G. F. STRINGER,
Clerk of the Board.
Offices of the Board,
173, Rosebery-avenue, E.C. 1,
12th March, 1930. 4614

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PUBLIC NOTICES

Staffordshire County Council.

ROADS AND BRIDGES DEPARTMENT.

APPOINTMENT OF DRAUGHTSMEN.

APPLICATIONS are INVITED for the POSITIONS of DRAUGHTSMEN at a commencing salary of £160 per annum, rising, on approved service, to £210 per annum.

Candidates must be neat and expeditious draughtsmen and have had considerable experience in the office of a Structural or other Engineer; must be able to ink-in original drawings and trace same, and must be capable of computing areas and other simple quantities. Preference will be given to those who have attended technical classes and have gained certificates of proficiency.

The appointments will be to the established staff and will be subject to salary deductions of 5 per cent. under the Local Government and other Officers' Superannuation Act, 1922.

The appointments will be subject to one month's notice in writing on either side.

Applications, on the prescribed forms obtainable from the undersigned, will be received not later than 22nd March, 1930.

ROBERT S. MURT, Assoc. M. Inst. C.E.,
County Surveyor.

County Surveyor's Office,
Lloyd's Bank Chambers, Stafford,
8th March, 1930. 4594

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a LOCOMOTIVE ENGINEER for Service in Argentine. Commencing salary £750 p.a. Only fully qualified engineers need apply. Age 26-32. —Address, 4590, The Engineer Office. 4590 A

WANTED, Capable Young ENGINEER to Run Sales Office in London. Organising ability essential.—Address, with full details, in confidence, 4611, The Engineer Office. 4611 A

WANTED, ENGINEER REPRESENTATIVE in India, to co-operate with local agents of leading firm of British Cable Makers.

Good education, sound electrical engineering training, first-class health and personal qualities essential. Age between 25 and 35 years.

Address, stating salary required and enclosing synopsis of training, with copies of recent testimonials, P6805, The Engineer Office. P6805 A

WANTED, for Service on North Borneo State Railways, YOUNG MECHANICAL ENGINEER, about 25 years old, as ASSISTANT LOCOMOTIVE SUPERINTENDENT.—Apply, by letter, marking envelope "Railway," with copies of testimonials, to THE SECRETARY, British North Borneo (Chartered) Co., 17, St. Helen's-place, London, E.C. 3. 4622 A

WANTED, GENERAL MANAGER for a Technical Commercial Business; must have engineering degrees, experience in selling and management, full knowledge of Structural Concrete Work, Plain and Reinforced. Salary £600 to £800, with prospects, depending on experience and qualifications.—Address, 4616, The Engineer Office. 4616 A

WANTED, RESIDENT SALES ENGINEERS, Well-known line Pneumatic Drills and Grinders. Connection essential. Commission basis. Territories open: (1) Liverpool and district; (2) Lancashire and Cheshire, except Liverpool district; (3) Cardiff and S. Wales, including Bristol.—Write, giving full qualifications, references, MARBAIX LTD., Adelaide House, London, E.C. 4. 4620 A

EQUIPMENT & PROGRESS

IN considering ways and means of improving business, the question of additional plant and the replacing of inefficient machines by modern equipment must arise.

There are cases, however, in which financial considerations make it necessary to postpone the carrying out of such projects until an indefinite future date.

We can obviate such difficulties, however, and enable plans to be put into immediate operation, by supplying high-class modern plant on special payment terms. These terms compare favourably with those which can be obtained from Bankers, with the additional advantage that all transactions are financed by ourselves, thus ensuring the strictest privacy.

Not only Machine Tools, but Engines, Boilers, Motors and Plant of every description can be supplied.

Address all enquiries, which will be treated confidentially, to:—

The Financial Secretary.

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LONDON, E.14.

Branches: BELFAST, BIRMINGHAM, NEATH, NEWCASTLE, SHEFFIELD and BRUSSELS.

THE MITCHELL CONVEYOR & TRANSPORTER CO., LTD.,

ALL CLASSES OF HANDLING MACHINERY.
45-50, Holborn Viaduct, LONDON, E.C.1.
Grams: Miconiraco, Cent, London. Phone: Holborn 2822.

WAGON TIPPLERS, TRANSPORTERS, CONVEYORS, TELPHERS, CRANES, LOCO. COALING PLANTS, GRABS, COMPLETE BOILER HOUSE EQUIPMENT, AERIAL ROPEWAYS.

SITUATIONS OPEN (continued)

AN Established MANUFACTURING COMPANY on the Continent REQUIRES the SERVICES of a SUPERVISING ENGINEER, familiar with Steam and Electrical Equipment, and preferably with some knowledge of construction. Please give age, education, experience, salary required, and knowledge of continental languages, if any. Correspondence confidential.—Address, 4613, The Engineer Office. 4613 A

ASSISTANT TECHNICAL MANAGER REQUIRED, with first-class experience Condensing, Evaporating, Descrating and Feed Heating Installations for land and marine use.

To take full responsibility for design and control drawing-office.

Salary £500 to £650 per annum, according to qualifications.

State age, full particulars of experience, salary required, and when at liberty.

Replies will be treated in strictest confidence.

Address, P6790, The Engineer Office. P6790 A

ENGINEER of Good Education, with Organising ability and Works experience, capable of Controlling Production and Labour in large Factory engaged in Mass Production of Small Work for Electrical Trade. State experience, salary required and age. —Address, P6806, The Engineer Office. P6806 A

HEATING ENGINEERS WANTED, Capable of designing and superintending the installation of Hot Water and Steam Heating Plants on all modern systems.

Applications, stating age, experience, and salary required, to the MANAGING DIRECTOR, Musgrave and Co., Ltd., St. Ann's Ironworks, Belfast. 4605 A

MECHANICAL ENGINEER REQUIRED in Chartered Civil Engineer's Office, Westminster, with special experience of design and construction of Dredging and Floating Plant, Cranes and Harbour Machinery generally. Commencing salary £500 to £600 per annum, according to qualifications.—Applications, giving age, full particulars of training and experience, with copies of recent testimonials, to M. E., c/o Messrs. A. W. Brown, 39, Tothill-street, S.W. 1. 4603 A

PRACTICAL MAN REQUIRED to Supervise Plate Shop. Experience necessary in Sheet Steel Working, Tank Making and Arc Welding. State age, experience and salary.—Address, 4506, The Engineer Office. 4506 A

PURCHASING AGENT and STOREKEEPER WANTED for abroad, with sound experience in Handling Engineers' Stores. Knowledge of Portuguese or Spanish essential.

State when free, also age and full particulars of training and experience, with copies of recent testimonials. Good salary paid to competent man.

Write, Box P. 101, Willings, 133, Moorgate, E.C. 2. P6779 A

REQUIRED for Permanent Position as Assistant Manager in Australia, ENGINEER with Locomotive and Power-house experience. Commencing salary £750 p.a. Age 30-35.—Address, 4589, The Engineer Office. 4589 A

RESIDENT SALES ENGINEERS WANTED having connection for Sale of high-class Electric Tools, Drills, Grinders, &c. Commission basis. Write giving details, references, past experience. Territories open: (1) Lancashire and Cheshire, except Liverpool district; (2) Birmingham; (3) Coventry; (4) Bristol and Cardiff; (5) Leeds and Bradford; (6) Glasgow; (7) Liverpool.—MARBAIX LTD., Adelaide House, London, E.C. 4. 4621 A

For continuation of Small Advertisements see page 4.

BY ORDER OF THE RECEIVER — STEPHEN P. CHILD, ESQ., F.C.A.

AC (ACEDES) CARS, LTD.,

THAMES DITTON, SURREY

within a few minutes' walk of Thames Ditton Station (Southern Railway)

EXTENSIVE FREEHOLD and LEASEHOLD

MANUFACTURING PREMISES

SERVICE STATION, GARAGE, SHOWROOMS, OFFICES, &c.

The premises are mostly of one storey and contain a FLOOR AREA of about 145,000 SQUARE FEET.

VALUABLE STOCK OF SPARE PARTS

NECESSARY IN THE MANUFACTURE OF A.C. CARS, also GOODWILL, PATENTS, &c.

THE HIGH-CLASS MODERN MACHINE TOOLS, ENGINEERING PLANT and EQUIPMENT

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30 Plain, Universal, Vertical and Horizontal Milling Machines, by Cincinnati, Browne and Sharpe, Garvin, Milwaukee, and others.
50 Capstan, Turret and other Lathes, by Potter and Johnson, Gridley, Cleveland, Browne and Sharpe, &c.
37 Centre All geared and Gap Lathes, 6in. to 14in., by La Pointe-Walcott, Hendy, Herbert, Pratt and Whitney, and others.
Herbert Combination Turret Lathes and Automatics.
35 Universal, Plain and Internal Grinders, by Churchill, Le Blond, Herbert, Browne and Sharpe, Heald, Landis, &c.
60 Radial, Pillar, Sensitive and Multiple-spindle Drilling Machines, by Herbert, Archdale, Tullis, &c.
14 Gear Cutters and Shapers, by Fellowes and others.
Horizontal and Vertical Boring Machines, by Dickinson and Garvin.
Fischer Oil Grooving Machine.
Gleason Bevel Gear Generating Machine.
11 Planing, Broaching and Slotting Machines, by La Pointe, Butler, and others.
Twin-spindle Profiling Machine, by Pratt and Whitney.
Woodworking Machinery, including **Saw Benches, Band Saws, Spindle Moulders, Planing, Thicknessing, and Tenoning Machines.**
Brinell Tester, Dynamometer, by Heenan and Froude. **Norton Crank Balancing Machine.**
Power Presses, 112-Cell Storage Battery Set, Hardening and other Furnaces.
30 Electric Motors, 1–50 H.P., 440 volts D.C. **Generators,** 150–30 kW, 440 volts D.C.
Large quantity of **Small Tools, Drills, Milling Cutters, Reamers, Gauges, &c.**
Crossley Suction Gas Plant and Engine. Tangye Suction Gas Plant and Engine.
Several Tons of **High-speed and other Bar Steel, Belting, Shafting, Plummer Blocks, &c.**
Laboratory Apparatus, Weighing Machines, Gantry Cranes, Office Furniture, Typewriters, Time Recorders, and miscellaneous items.

LEOPOLD FARMER & SONS

will SELL the ABOVE by AUCTION, in one or more lots, on the PREMISES

on Tuesday, 8th APRIL, 1930, and following days,

at 11 o'clock each day (unless previously disposed of in one lot).

Particulars, Plans and Catalogues of:
Stephen P. Child, Esq., F.C.A., Messrs. Trayton P. Child and Son, Chartered Accountants, 36, Queen-street, E.C. 4.
Messrs. Collisson, Prichard and Barnes, Solicitors, 20, Bedford-row, W.C. 1, and the
Auctioneers, 46, Gresham-street, Bank, E.C. 2, and Kilburn, N.W. 6.

A Seven-Day Journal

The British Engineering Standards Association.

IN order to commemorate the grant to it of a Royal Charter in May last, the British Engineering Standards Association gave a banquet in the Grocers' Hall, Princes-street, E.C., on Thursday, March 6th, Mr. Maurice Wilson, chairman of the Association, occupying the chair. The guest of the evening was his Royal Highness the Duke of York, who gave the toast of "The Association." He said that he was glad to have that opportunity of identifying himself with the work which the Association was doing, and he observed with pleasure the marked success it had achieved in persuading the various branches of the great engineering industries of the country to come together and unify and simplify their needs. He referred to the safeguards employed by the Association to prevent its work interfering with design, and expressed the hope that with the increased financial support given by the Treasury it would, once more, be possible to publish the specifications in foreign languages. In his reply, Mr. Maurice Wilson said that variety was very dear to human nature, and the fear of losing it was very real. The aim of the Association was to produce, by the consent of all concerned, standard specifications based on good average present-day practice, without aiming at an ideal which it would be too costly for industry to adopt. The movement was, in fact, but one aspect of the great reorganisation which was taking place throughout industry. Mr. Wilson mentioned the part that Mr. H. Skelton had played in 1895, in the initiation of the scheme, and subsequently Mr. Ll. B. Atkinson, in giving the toast of "The Guests," referred to Mr. Skelton as the father of British standardisation. When Mr. Skelton rose to respond to this toast, he had a very hearty reception. He expressed his firm belief in the recovery of British trade, and hoped that industry would make use of the Association's standards to maintain British quality at its traditional high level.

A Large Braced Girder.

AN interesting piece of reconstruction work involving the use of over 1000 tons of structural steel and the placing in position of what is believed to be the largest braced girder of its type in London, is now approaching completion at the Trocadero Restaurant of J. Lyons and Co., Ltd. By the courtesy of the owners and of Dorman, Long and Co., Ltd., who are supplying the steel work, we were able, a few days ago, to examine the new girder, which has a length of 70ft. and a depth of 14ft. 6in., and weighs close upon 62 tons. Its top flange is at fifth floor level and the bottom flange at the fourth floor level, while access to the kitchens on the fourth floor is obtained through one of the bays of the girder. All the material was taken into the building through a small opening some 10ft. square in Rupert-street, and most of the steel work was delivered in pieces, erected and riveted in actual position. The whole of the work, which has included the shoring up of floors and the transferring of loads to the new structure, has been done without any interruption of the ordinary routine of the restaurant. Two other features of the new equipment which may be of interest to engineers include a disappearing wall which is built upon a lattice girder 66ft. long with a depth of 15ft. The wall may be raised or lowered on five motor-operated screws placed at suitable points, enabling either one or two rooms to be used as may be required. For serving the main stage there is also a motor-operated moving cage with a length of 28ft. and a width of 8ft. The cage is worked by four motor-operated screws, the lifting appliances for both of these equipments being designed and supplied by Waygood-Otis, Ltd. The actual work of reconstructing the building is being carried out by Lyons' own constructional department to the design of the architect, Mr. F. J. Wills.

Electrical Developments in Great Britain.

IN an address delivered at the Surveyors' Institution on Monday last, Sir Harry Haward, Vice-chairman of the Electricity Commission, described recent developments in the electricity supply of Great Britain, with special reference to rural electrification. The national grid, he explained, was on its way to becoming an established fact. The question of routes in certain picturesque parts of the country threatened to impede progress, but he was glad to say that the difficulties were being overcome. Just as the public had got accustomed to the lines of the Post Office and those engineering features of our railway systems which were at one time thought to mar the landscape, so would it get accustomed to the Board's interlacing lines and their supporting towers. The protest about the Battersea power station and the nuisance proceedings regarding the Barton station were reminders that those super-power stations on which the grid depended were not popular with the dwellers in town or country. But while public attention was concentrated on the effects of the gaseous fumes from those stations, it ignored the emissions from many smaller stations in the process of being shut down, from factories, and from the coal fires of dwelling-houses. Smoke and grit should no longer be a nuisance in a modern power station, and recent experiments went to show that the oxides of sulphur could be eliminated. In distribution great advances were being made, and by the end of the year powers of distribution would extend over the whole of England and the greater part of Wales and Scotland, outside the moors and mountains. The main urban areas were being adequately provided for, and might be trusted to look after themselves. The problem to be solved was that of supplies in rural areas, but the country was on the eve of substantial developments. Large and small undertakers who had obligations to develop those areas were addressing themselves to the task, although not all of them with equal energy. The potential demand in the country districts during the next ten years had been computed at 280,000,000 units, representing a very substantial addition to the load on the national system, and much of that load would be provided by supplies to farmers. The innate conservatism of the British farmer and his dislike of new methods had to be overcome by practical demonstrations of the advantages of the application of electricity to agriculture.

Survey of British Coalfields.

IN connection with the physical and chemical survey of our national coal resources, which is being carried out by the Department of Scientific and Industrial Research, a committee has now been appointed to deal with the West Yorkshire area. It includes, besides the representatives of the department and local scientists, members of the West Yorkshire Coalowners' Association, the Midland Institute of Mining Engineers, and a representative of the Geological Survey of Great Britain. The committee will advise the Department as to the seams to be investigated and the large scale work which it may be advisable to carry out, and it will bring to the notice of the Department any special problems which may require investigation. Survey laboratories have been established in the coalfields of South Yorkshire, Nottinghamshire and Derbyshire, Scotland, Northumberland and Durham, North Staffordshire and South Wales, while in Lancashire and Cheshire work is being carried out in the laboratories of the Coal Research Associations of those counties. A further laboratory is being arranged for dealing with the coalfields of Warwickshire, Cannock Chase, South Staffordshire and Leicestershire, and when these laboratories have all been put to work the area under survey will embrace areas in which about 96 per cent. of the coal in Great Britain is mined.

The Central Scotland Electricity Scheme.

IN a statement prepared by Mr. A. A. M'Coll, Engineer for Scotland of the Central Electricity Board, interesting information is given concerning the Central Scotland scheme, which provides for the erection of about 250 miles of 132,000-volt transmission lines and for interlinking various steam and water power stations in the country. According to the statement, an opening ceremony will take place on April 30th of the recent extensions which the Edinburgh Corporation has made at the Portobello power station. The closing of switches at the station will connect the East and West of Scotland, thus permitting power to be transmitted backwards and forwards between Greenock, Paisley, Glasgow, the Clyde Valley Company's power stations, the power stations of the Scottish Central Electric Power Company at Bonnybridge, and the Edinburgh Corporation, with a later extension to Dundee. The main function of the scheme is to provide for unification of control of all the main generating stations in Scotland, with ultimate elimination of the less efficient and older stations. Arrangements are being made by the Grampian Power Company to deliver power from its new hydro-electric station at Loch Rannoch into the Board's grid lines at a point near Abernethy, and the large inter-connected system which the Board's lines make possible will ultimately lead to the development of the extensive water powers in the Northern Highlands. The lines which the Board may construct later between Kilmarnock and Carlisle will permit of the development of the water powers in the county of Kirkcudbright, which are estimated to be capable of supplying a demand of 102,000 kilowatts.

The British Corporation for the Registry of Shipping and Aircraft.

AT the annual meeting of the British Corporation for the Registry of Shipping and Aircraft recently held in Glasgow, reference was made to the forty years' work of the Corporation and its recent association with the construction and classification of aircraft. From the beginning the Corporation has been closely identified with British Freeboard Law, and by its constructive criticism as an assigning authority it has helped in the advance which culminated in the 1927–29 Load Line Committee Report. It is hoped that the forthcoming International Load Line Conference will carry the work still further and accept the report and settle the load line problem for all countries. In the absence of Mr. Maurice E. Denny, Professor Hillhouse submitted the report of the Technical and Aviation Committees and referred to the great variety in character and type of the ships machinery and equipment with which they had to deal. Such variety made it very difficult to lay down or to apply hard and fast rules, and it was necessary in most cases to return to first principles when determining arrangements and scantlings. Attention had recently been given to questions of structure, cast steel cables, and the streamlining of rudders and appendages. On the machinery side advances had included the use of higher steam pressures, pulverised fuel and the reduction of waste heat losses. Since last year 90 per cent. of the ships classified by the Corporation had been fitted with streamlined rudders and sternframes. For cylindrical boilers steam pressures of 250 lb. to 275 lb. were quite common, and 400 lb. was not regarded as abnormal for water-tube steam generators. In the case of oil engines higher mean effective pressures were being employed, with higher efficiencies and greater ratios of horse-power to weight. After three years of work the inspecting department which had been created was now handling a large amount of aviation work, and since last June the Air Ministry had recognised their inspection work. In addition to making the annual surveys for renewals of certificates of airworthiness, regular quarterly inspections without additional fees had been instituted and many flying clubs and private owners had availed themselves of the facilities offered.

Great Western Railway Dock Extensions.

THE Great Western Railway announces that it has received Government approval for the expenditure of £3,000,000 on further improvements to its dock system in South Wales. Since the docks came under the control of the railway authorities nine years ago, a large sum has been spent on their upkeep and improvement. The new work will include an additional lock entrance at Swansea docks, and extensions to the piers at Port Talbot. New cranes and appliances are to be installed at Newport, Barry, Cardiff, and Penarth, with a view to handling the new 20-ton wagon traffic.

New Shipbuilding Orders.

DURING the last few days the Anglo-Saxon Petroleum Company, Ltd., the shipping company of the Royal Dutch Shell Group, has placed orders with shipyards in Great Britain and on the Continent for no less than twenty new motor tankers. The total value of the orders is estimated at about £3,600,000. Each of the vessels will have a deadweight capacity of about 11,500 tons, and will be propelled by twin-screw Werkspoor supercharged engines, the designed speed being about 12½ knots. In this country two ships will be built by Harland and Wolff, Ltd., at the firm's Govan yard, and two by Swan, Hunter and Wigham Richardson, Ltd., at Wallsend-on-Tyne. Two further ships are to be built at Belfast by Workman Clark (1928), Ltd., and two by Hawthorn, Leslie and Co., at Hebburn-on-Tyne. It may be recalled that the last-named firm has already under construction three vessels for the Anglo-Saxon Petroleum Company, Ltd. The continental orders are divided between shipyards in Holland, Germany and Italy. Both the hulls and propelling machinery will be built to the owners' own specification, and by adopting supercharging the maximum output in relation both to space occupied and weight will be obtained. An order has also been received by Vickers-Armstrongs, Ltd., for a large electrically propelled passenger liner for Furness, Withy and Co., Ltd., of London. The liner will be built at the firm's Naval Yard at Walker-on-Tyne, which has now been closed for some eighteen months. The electrical propelling equipment will be constructed at the engineering works of the General Electric Company at Witton, Birmingham, in collaboration with the Barrow-in-Furness engineering department of Vickers-Armstrongs, Ltd., at which latter works the boilers and the auxiliary machinery will be constructed. These orders will give considerable satisfaction in shipbuilding yards and the allied industries. The announcement is also made that the Cunard Steamship Company, Ltd., has sent out preliminary inquiries and specifications for a new fast Atlantic liner to replace the "Mauretania."

Inspection of Factories.

IT is announced by the Home Secretary that, as a result of the recommendations made by the Departmental Committee which was appointed under the chairmanship of Sir Vivian Henderson to inquire into the strength and organisation of the factory inspectorate, the Government has decided upon several important changes in this branch of the Civil Service. The general inspection staff will be increased from 180 to 243, and an additional division will be formed in the South-East of England. The men's and women's staffs are to be amalgamated and the engineering, electrical and medical branches of the service are to be increased. Competitions for the electrical and medical inspectorates will shortly be held, and the additional engineering inspectors will be appointed from the existing general staff.

The Rolling of Metals.

By J. SELWYN CASWELL, M.Sc., A.M.I. Mech. E.

No. III.*

The Deformation of the Stock.

Deformation of the material commences simultaneously with the stressing of the material, elastic deformation or distortion occurring first, and plastic deformation occurring afterwards.

The amount of elastic deformation is very small, and its limit is determined by the stress at which the atomic arrangement can recover its original configuration after the removal of that stress.

A slight increase in the value of the stress would produce permanent distortion of the original atomic arrangement, and the alteration is principally the result of slip within the crystals and relative movement between the crystals.

The general effect of deformation is to harden the material, although some alloys of tin and lead are softened.[11] The phenomenon is described as work-hardening, which, according to Sir George Beilby's theory, was regarded as due to the formation at all the internal surfaces of slip or shear, of mobile layers similar to those produced on the outer surface by polishing. The mobile layers retained their mobility for a brief period, and then solidified into a vitreous or amorphous state, this amorphous material being regarded as the cementing material between the crystals.

It was suggested by Sir Alfred Ewing and Dr. Rosenhain[12] that when slip had been exhausted on the most favoured planes, slip occurred on other less favoured planes, and therefore deformation would be accompanied by increasing resistance to deformation.

Professor Maurer[13] attributes the hardening of worked metals to the development of severe internal stress conditions.

The writer believes that the most recently published authoritative views regarding the behaviour of metals under applied stress are those expressed by Dr. Rosenhain[8] and Dr. Carpenter[14] respectively in the Metallurgical Supplement of THE ENGINEER, October and November, 1928, and the "William Menelaus" lecture of the South Wales Institute of Engineers, December, 1928, and they are briefly summarised below.

Dr. Rosenhain submits a theory intended to explain the phenomena of hardening and softening which occur in worked metals, and he suggests that recrystallisation may play only a secondary part in the phenomena.

In order to avoid the misconception attached to the word "amorphous," Dr. Rosenhain substitutes the word "irregular" to define the state of those parts of the material in which no regular atomic arrangement exists.

The view of work hardening advocated is that disruption of the atomic lattice structure occurs in the regions of slip, and therefore in this "irregular" material there would be no crystal planes on which slip could occur. The impossibility of slip in this material and the distortion of the adjacent crystal lattice layers is regarded as the cause of work-hardening.

It is suggested that the hardening of the crystal aggregate is due to the effect of the "irregular" material in the boundaries in producing distortion of the adjacent regions of the crystals.

In the harder metals resistance to movement of the atoms appears to be very great, and this is what may be expected at temperatures which are so far below their melting point. Resistance to movement in the "irregular" zones after the settling down of the atoms, following the initial disturbance, will depend on the relationship between the working temperature and the melting point of the material. It might be expected that the settling down process will take longer in the harder metals, and resistance to further movement will be greatest in metals with high melting points.

Deformation of the irregular material can occur only by relative movement between the atoms or groups of atoms, and such movement is analagous to viscous flow, the flow obeying approximately the same laws as viscous flow.

At temperatures not far below the melting point of the metal it will be expected that the irregular layers are soft and mobile, and at temperatures far below the melting point these layers will be hard and highly resistant to change of shape. This implies that for each metal and alloy there is a temperature at which work-hardening cannot occur, because the irregular material is sufficiently mobile to allow recovery of the distorted crystal lattice to take place more or less quickly.

Slip in the crystal is practically unaffected by time, whereas the opposite is the case of the "irregular" material.

It is finally suggested that the behaviour of metals under applied stress is largely attributable, therefore, to the existence and properties of the irregular material at the crystal junctions and on the surfaces of slip in the crystals.

Dr. H. C. Carpenter[14] considers that the present-day evidence is against the assumption that work hardening is the result of the production of an "amorphous phase." He points out that the researches of Sir William Bragg have shown that even in the case of so heavily worked a metal as thin gold leaf there is no evidence of the production of an amorphous structure.

According to the amorphous phase theory, slip on a plane increases the resistance to further slip on that plane, but the work done by Taylor and Elam[15] in their analysis of the deformation of a single crystal of aluminium showed that the resistance to further slip on a slip plane is not increased.

Under the action of mechanical forces, metal crystals change their shape, and this takes place by slipping of the component parts of the crystal. The crystals also change their properties, and, in some unknown way, become increasingly more resistant to further change of shape, and, at high temperatures, this change in the properties disappears as fast as it is produced.

In the crystal aggregate the orientation of each crystal is different from that of its neighbours, and Dr. Carpenter states that it is this difference in the orientation which is responsible for the difference in the properties of a crystal aggregate and a similar mass comprised of only one crystal.

The suggestion that the crystals are held together by a kind of cement is dismissed as untenable, and present knowledge suggests no more than, that, at the crystal boundaries, the lattice of each crystal adapts itself so that the transition from one crystal to another is gradual.

The foregoing remarks apply to pure metals and alloys containing no insoluble impurities.

It is explained that polycrystalline test bars under stress behave in an isotropic manner, and this is attributed to compensation and mutual adjustment among the crystals, deformation of each crystal being controlled by the deformation of the mass rather than its own directional properties.

There are two aspects to consider in the deformation of the crystal aggregate, viz., the isotropic behaviour and the directional properties of the individual crystals. The interference of adjacent crystals prevents natural slip along the favourable planes in each crystal, and there is, therefore, relative movement of the crystals with respect to one another along the boundary surfaces, and elastic and plastic distortion of the individual crystals. The work of Edwards and Pfeil[16] is referred to regarding the effect of crystal size on the properties of the crystal aggregate, and their work, which was carried out on iron specimens, showed that there is a particular crystal size at which the stress-strain properties attain maximum values. They concluded that the average crystal size was the variable which controls the different mechanical properties of the material tested.

Dr. Carpenter suggests the following reasons for this result :—

Decrease in the crystal size, by increasing the number of changes in orientation per unit volume, increases the extent of the mutual interference, and thereby increases the value of the limit of proportionality, the yield point and the strength.

But increased resistance to slip within the crystals promotes an increased tendency to slip between the crystals, and this may be favoured by a decrease in the crystal size. Consequently the limit of proportionality, the yield point and the tensile strength are not progressively raised as the crystal size decreases, but are actually lowered beyond a critical value.

Recrystallisation in Cold Working.

Considerable differences of opinion exist regarding the occurrence of recrystallisation in the case of cold-worked metals. Much of the work done on this subject has been concerned with the determination of the relationship between the physical properties of the stock, the energy absorbed and the amount of deformation produced. Some of the curves obtained show points of inversion, and these have been submitted as evidence indicating the probable occurrence of recrystallisation and consequent slight softening of the metal.

The stress values calculated by the writer and plotted in Fig. 1, *ante*, show the type of curve produced in the experiments on the effect of cold work.

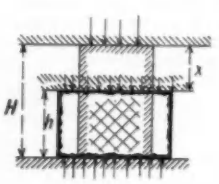


Fig 15 Unretarded Compression.

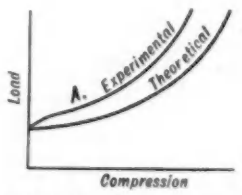


Fig 16a Theoretical and Experimental Curves.

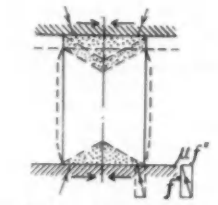


Fig 16b Zones of Retarded Deformation

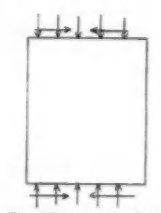


Fig 17. Forces on Specimen in Compression.

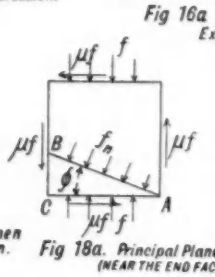


Fig 18a. Principal Planes. (NEAR THE END FACES)

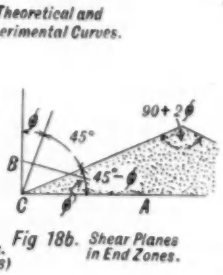


Fig 18b. Shear Planes in End Zones.

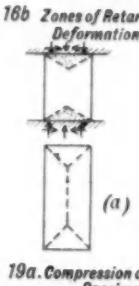


Fig 19a. Compression of RectLAR Specimen

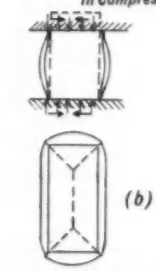


Fig 19b. Deformation of RectLAR Specimen.

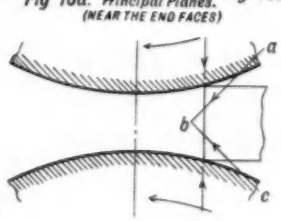


Fig 20a. Approx: Shear Planes.

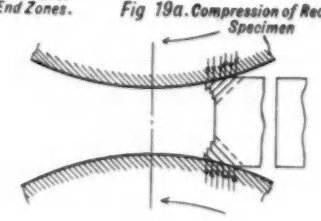


Fig 20b. Collapse of Corners.

"THE ENGINEER"

Criticism, while admitting the validity of the results obtained, has been centred on the insufficiency of the evidence, the method of plotting the results and on the variable factors associated with the mode of deformation. The method sometimes adopted of plotting the total energy used to operate the deforming tools against the variation of the physical properties can be very misleading, because the total energy includes the energy required to overcome the frictional resistance accompanying the operation of the deforming tools, and this energy varies considerably according to the magnitude of the load on the deforming tools.

There are, however, certain well-known phenomena associated with cold working which suggest the probability of recrystallisation at ordinary temperatures, and the relationship between the working temperature and the melting point of the metal, referred to by Dr. Rosenhain and Dr. Carpenter, has an important bearing on the subject.

A bar of iron which has been overstrained and therefore rendered pseudo-elastic will not give a straight stress-strain relationship, but after a few days' rest or heating in boiling water for a short time the bar is restored to a much improved elastic condition. The improvement is probably due to the recovery of some of the displaced atoms to their original position in the neighbouring crystal lattice.

Professor Lea has shown that the same phenomenon appears in the reduction of the area of the hysteresis curves following the application of a load in a torsion test, applied first in one direction and then in the other.

Cold working is accompanied by the generation of a small quantity of heat, and in view of the theories

* No. II. appeared March 7th.

[11] Hargreaves, Inst. of Metals *Journal*, 1927, II.

[12] Ewing and Rosenhain, "The Crystalline Structure of Metals," "Phil. Trans.," Roy. Soc., Vol. 193, 1900.

[13] THE ENGINEER Met. Suppt., 1928.

[14] Menelaus Memorial Lecture, 1928, South Wales Institute of Engineers, Vol. XLIV., No. 6, 1928.

[15] "Plastic Extension and Fracture of Aluminium Crystals," "Proc.," Roy. Soc., No. 108.

[16] Edwards and Pfeil, *Journal* Iron and Steel Inst., 1925.

just outlined, it is probable that the heat generated may be sufficient to facilitate the recovery or recrystallisation of some of the displaced atoms, and consequently, the value of the plastic stress will increase more or less rapidly according to the magnitude of this effect.

An important phenomenon noted by metallurgical workers is that of crystal rotation under continued application of the deforming stress. The orientation of all the crystals tends to some particular direction such that one of the principal axes in each crystal lies at right angles to the plane of rolling, and it is not appreciably altered by subsequent annealing. It is not improbable that the high tenacity of drawn wire may be due to this tendency toward uniform orientation.

Deformation produces considerable relative movement between the different parts of the material, and the amount and character of the movement depends on the magnitude of the load and the area on which it is applied. Consideration of the manner in which flow occurs in the rolling mill is a matter which will be discussed separately.

The general conclusions regarding the value and the variation of the plastic stress, as related to rolling, are recorded below.

(1) The stress value depends on the rate of deformation, but its value is not appreciably altered except at high rates of deformation.

(2) The value of the stress required to produce additional deformation immediately after previous deformation is less than that required after an interval of time has elapsed after the first application of the load.

(3) Work-hardening of the material increases the resistance to deformation, and, according to (2), its effect will be greater when the metal is allowed to rest between successive applications of the deforming stress.

(4) The stress values during the progress of the "bite" will approach nearer to the plastic stress value of the deformed material under static conditions of loading, as a result of the gradual decrease of the velocity of application of the stress as the end of the "bite" is approached.

(5) The slip which occurs on the roll face will give rise to a higher stress value in the zone of no slip than would be required under conditions of no slip.

(6) Above the recrystallisation temperatures of the metal the stress values will not be increased as the "bite" proceeds, and in certain of the soft metals the stress may fall to a lower value.

(7) There is reason to believe that some phenomena similar to recrystallisation occurs in cold rolling.

(8) The value is related to the size of the crystals and the orientation of the crystals.

The Flow of Metal under Applied Stress.

The distortion which rolling produces is very complicated, and perhaps the greatest distortion is produced in the rolling of sections. A great deal of important experimental work has been done with the object of determining the distortion which occurs, and the experiments have generally consisted in rolling stock which had been built up, marked, or penetrated by rods or screws in order that the effects of deformation may be readily observed. Etching of the rolled material is also another method which has been used for this purpose.

The present aim is to discuss this matter in the light of what has gone before, and before proceeding with the consideration of the deformation produced by rolling some characteristics of plastic deformation by simple compression will be discussed.

A perfectly plastic material, *i.e.*, one which deforms continuously under a constant stress, which is compressed between frictionless plattens, would deform as shown in Fig. 15, and the load-compression curve would be a hyperbola.

The load W_x for any degree of compression $x=a_x f$, where

a_x = the cross sectional area of the specimen after compression to the amount x,
f = the plastic stress.

$$a_x = \frac{a\,H}{H-x}$$

where

a = the original area of the cross section, and
H = the original height of the specimen; and then

$$W_x = \frac{a\,H\,f}{H-x}$$

since the volume and the geometrical form of the cross section remain unchanged.

The change of dimensions can occur only as a result of shear or relative movement between all parts of the mass, and it may be shown that the planes of maximum shear are inclined at 45 deg. to the direction of loading and that the value of the shear stress is $\frac{1}{2}\,W/a$. This is accompanied by a normal stress $p_n = f\cos^2 45° = f/2 = \frac{1}{2}\,W/a$.

The compression of perfectly plastic material would take place by symmetrical slip or shear on innumerable planes, all of which would be inclined at 45 deg. to the direction of loading.

The metals which can be deformed are imperfectly plastic, principally on account of the work-hardening which accompanies deformation, and the mode of deformation is influenced by the shape of the deforming tools.

In the ordinary compression tests a cylindrical specimen under increasing load, takes up a barrel shape which becomes more pronounced as the deformation proceeds. The alteration in shape is due to the frictional constraint exerted by the plattens of the deforming tools, although the shape has been attributed by some workers to different degrees of interpenetration of the cone surfaces, formed by the innumerable planes of slip. If the friction is eliminated the sides of the specimen would remain straight and parallel as deformation proceeds. At the Kaiser Wilhelm Institute for Steel Research, bulging of cylindrical specimens is entirely eliminated by using conical plattens in which the cone angle corresponds to the coefficient of friction between the surfaces of the platten and the specimen.

The shape of the load-compression curves for the plastic metals differ considerably, therefore, from the hyperbolic form obtained in the hypothetical case, both on account of the work-hardening of the material and the influence of the deforming tools. The general form of the experimental and the theoretical curves is shown at (*a*) in Fig. 16*a*. It will be noted that there is a point of inflexion on the experimental curve at A, and it has been shown by Meyer and Nehl[17] that this point may be regarded as an indication of the meeting of the apices of the conical zones of retarded deformation—see Fig. 16 (*b*). They observed also, that the angles of the cones and the position of the point A depended on the dimensions of the specimen. A short cylindrical specimen gives a large cone angle, due to the diminished value of the frictional forces up to the point of contact of the cones and the point of inflexion A occurs earlier.

The manner in which the friction of the plattens affects the stress distribution in the specimen is discussed below.

The distribution of stress at the ends will be different from that in the middle of the specimen. In the middle the direction of the principal shear stress will be inclined at 45 deg. to the direction of loading, but at the ends this direction is altered by the influence of the external frictional forces.

The external loads on the specimen are represented in Fig. 17, and it will be seen that a particle of the material near the end will be under the direct stress due to the load and complementary shear stresses which are produced by the frictional forces.

The stress conditions as they apply to the particle considered are shown in Fig. 18 (*a*). The principal planes will lie in some other direction than 45 deg. to the direction of loading, and one of these is shown at A B in Fig. 18 (*a*).

The equilibrium of the triangular prism A B C is as follows:—

Resolving vertically:

$$f\,A\,C + \mu f\,B\,C = f_n\,A\,B\cos\varphi$$

i.e., $f\,A\,B\cos\varphi + \mu f\,A\,B\sin\varphi = f_n\,A\,B\cos\varphi$

$$\therefore\ \mu f\sin\varphi = (f_n - f)\cos\varphi,$$

and
$$\tan\varphi = \frac{f_n - f}{\mu f} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Resolving horizontally:

$$\mu f\,A\,C = f_n\,A\,B\sin\varphi$$

$$\mu f\,A\,B\cos\varphi = f_n\,A\,B\sin\varphi,$$

$$\therefore\ \tan\varphi = \frac{\mu f}{f_n} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Equating (1) and (2),

$$\frac{f_n - f}{\mu f} = \frac{\mu f}{f_n}$$

$$\therefore\ f_n^2 - f_n f - \mu^2 f^2 = 0$$

and
$$f_n = \tfrac{1}{2} f \pm \sqrt{\frac{f^2}{4} + \mu^2 f^2}$$

$$= f\,(\tfrac{1}{2} \pm \sqrt{\tfrac{1}{4} + \mu^2})$$

The angle φ:

$$f_n = \mu f \cot\varphi,$$

and
$$\frac{\mu\cot\varphi - 1}{\mu} = \tan\varphi,$$

$$\therefore\ \mu\cot\varphi - 1 = \mu\tan\varphi$$

and
$$\mu\,(\cot\varphi - \tan\varphi) = 1.$$

$$\therefore\ \mu\,\frac{2}{\tan 2\varphi} = 1$$

or
$$\tan 2\varphi = 2\mu. \quad . \quad . \quad . \quad (12)$$

The maximum shear stress will take place on planes inclined at 45 deg. to the plane A B, as at 18 (*b*), and therefore the angle of the cone, under symmetrical deformation, will now be 90 deg. $+ 2\varphi$ instead of 90 deg., and the maximum shear will stress on these planes is

$$\frac{f_n}{2} = \frac{f}{2}\,(\tfrac{1}{2} + \sqrt{\tfrac{1}{4} + \mu^2}) \quad . \quad . \quad . \quad (13)$$

This value is greater than that on planes outside the zone which is under the influence of friction, and therefore, slip will occur in the middle zones first. The cone angle depends on the value of 2φ, and therefore, on the value of the coefficient of friction μ, and different cones would result from differences in the friction on the ends, the cone disappearing entirely when $\mu = 0$.

[17] Meyer and Nehl, *Stahl und Eisen*, 48, Nov., 1925.

The writer has carefully measured the cone angle, as revealed by Fry's etching reagent, in one of Meyer's and Nehl's photographs, and its value is 104·5 deg., *i.e.*, the value of $2\varphi = 14{\cdot}5$ deg. and $\varphi = 7{\cdot}75$ deg.

This value corresponds to a value of $\mu = 0{\cdot}137$, and this is approximately the value of the coefficient of friction between the dry surfaces of the specimen and the plattens of a testing machine.

It is probable that there would be slight variations of the value of μ as the deforming load increases, and therefore, the value of the cone angle would also change. During the early stages of the deformation the load is determined by slip in the middle zones, and after the meeting of the apices of the conical zones, the load is determined by slip in these zones, and its magnitude is considerably influenced by the extent of the friction on the ends of the specimen.

It would be expected, therefore, that the rolling of thin stock and thick stock under the same conditions of draught and roll diameter would require a greater amount of energy in the case of the thin stock.

The Deformation of Rectangular Specimens.

Much of the experimental work on the compression of ductile materials is carried out on cylindrical specimens, and it is now necessary to apply the conclusions to the deformation of rectangular specimens as a preliminary to the consideration of deformation in the rolling mill.

Lateral spreading under compressive loads is due to the resultant of the shear stresses on the slip planes. The slip planes are everywhere equally inclined to the direction of loading, and therefore equally inclined to the surfaces on which the load is applied.

In the case of rectangular specimens, slip occurs on planes which are equally inclined to the surface of the specimen, and the planes intersect as shown in Figs. 19*a* and *b*. The general direction of the flow of metal at any point is perpendicular to the sides of the specimen, and the amount of flow at any point will be proportional to the distance of the point from the inclined slip plane forming the approximate boundary between the zone affected by the friction on the ends and the unaffected parts of the specimen.

In the middle zones, between the deforming tools, the change of the contour will occur most rapidly, near the corners, because of the interference of the slip planes at these points. As deformation proceeds, flow will always tend to a direction perpendicular to the contour, and if deformation proceeds far enough, the corners will be replaced by a smooth curve in these middle zones.

The end zones will retain their shape longer than the middle zones, and when a change occurs, it will occur at a slower rate than that occurring in the middle zones. A change in the contour of the end zone, *i.e.*, of the parts near the plattens, will be accompanied by an increase in the area of contact, and consequently a greater part of the specimen becomes affected by the friction on the ends. It is of interest to note that the effect of end friction plays a considerable part in determining the load at which brittle materials fail under compression, failure taking place at a much lower load when end friction is much reduced or eliminated, and it is recorded by Mesnager[18] that marble blocks fail under about one-third of the load when end friction is eliminated.

The following matters have now been discussed:—

The plasticity of materials,
The characteristics of the rolling mill as a deforming tool,
The value and variation of the plastic stress,
The movement of the stock between the rolls, and
The general behaviour of plastic materials under simple compression,

and the character of the deformation in the rolling mill can be now discussed against this background.

(To be continued.)

[18] Mesnager, Amsterdam International Congress on the Testing of Materials, 1927, Vol. II.

Institution of Mechanical Engineers.

An extra general meeting of the Institution of Mechanical Engineers was held on Friday evening of last week in London for the purpose of hearing and discussing a paper, "The Strength and Design of Fusion Welds for Unfired Pressure Vessels," by Mr. L. W. Schuster, of the British Engine, Boiler, and Electrical Insurance Company, Ltd., Manchester. Much of the information given in the paper was detailed in the company's Technical Report for 1928, a summary of which was given in our issue of September 13th, 1929. The paper was a lengthy one, and was presented by the author in abstract. Elsewhere in this issue we reprint that portion of it which gave rise to most of the discussion, namely, the Appendix, in which Mr. Schuster gave provisional rules for fusion welded non-fired pressure vessels.

The President, Mr. Pendred, moving a vote of thanks to the author, described the paper as encouraging, in that it showed what other countries were

doing in the matter of fusion welded pressure vessels, and that there was no reason why we should not do at least as well in the same direction. In this country welding was looked upon with considerable suspicion. If the Institution could do anything to encourage the evolution and adoption of sound welding methods, it would confer a benefit on British engineers.

Mr. A. L. Haas agreed with the view that welding was regarded with suspicion in this country. A sound technique of welding was lacking, and too often unskilled or untrained labour was employed. It would, in his opinion, be a very long time before British engineers could be persuaded to adopt welding for boiler construction. There was too much doubt as to what happened inside the weld. He urged that technique should be improved in order that such doubt might be eliminated.

Mr. Ballard, speaking as one having practical experience with welding in the production of fabricated steel parts for electrical machines, said that by keeping a check on the welders, considerable reliance could be placed on the work which they did. With bare-wire electrodes, which he employed for 75 per cent. of his work, he found that strengths of 22 to 23 tons per square inch in the weld were readily obtainable. He had also employed the atomic hydrogen system of welding, and found that it gave extremely ductile welds. With that system it was quite easy to make welds that would pass a 120 deg. bend test. He was not, however, quite certain whether it was always desirable to aim at high ductility in a weld. For some purposes high-tensile strength was the prime consideration.

Mr. W. A. Stanier, of the Great Western Railway, spoke as a user of welded vessels. The first difficulty with such vessels was, he said, the design of the joint. The second was to obtain a sound job from the welders. He suggested that as in the Great Western shops a system should be adopted of testing individual welders' work, and periodically of testing the welding materials which were employed. It was sometimes difficult to prevent welding being adopted for purposes for which it should not be used. He instanced in this connection the modification of the small end of some connecting-rods. Studs in the small ends were no longer required. The stud holes were welded up and rebored and ground as plain holes. In a very short time a crack developed at the holes. It spread and eventually led to the end of a cylinder being knocked out. On the question of ductility, he said that his experience was that the ductility of a welded joint was always less than that of ordinary engineering materials.

Mr. F. E. Pollard pointed out that fusion welding had several fields of usefulness. For example, superheater tubes had for many years been welded by the fusion process, and had not betrayed the confidence placed in them. Hydro-extractor cages were similarly welded, and he had no record of complaints or failures. Many parts of textile and other machines were satisfacotrily repaired by fusion welding. It was therefore undoubtedly true that in the past fusion welding had had a considerable and a successful application. Recently, however, the process had been applied in the manufacture of air pressure vessels, such as those used in garages for inflating tires, in connection with road drills and so forth. Such applications of the process were looked upon with the greatest suspicion, and very few insurance companies were prepared to take any risk in connection with them. After a life of two or three years there was a grave possibility of the explosion of the fusion welded pressure vessels to which he was referring. Unless the vessels were made with properly designed joints and ends, they would not stand up to their work for any lengthy period. From the legal point of view, the Factory Acts contained no regulations prohibiting the employment of welding processes or specifying any particular type of construction, such as riveting. In New Zealand, however, there was a fairly stringent code of Government rules covering welded vessels. It was very desirable, he thought, that some authoritative and impartial body should take up the question of fusion welded pressure vessels, and he would like to suggest that the Council of the Institution should appoint a committee to draw up rules for the practice of welding. The work described in the paper was undoubtedly good, but it should be remembered that it was originated by an insurance company.

Dr. J. H. Paterson described the paper as constructive and as deserving constructive criticism. He did not agree with the view that welding was everywhere looked upon with suspicion. His company used many high-pressure welded vessels, not because welding was economical, but because it gave a result which no other process of jointing could give. In the course of his summary the author had shown illustrations of some American arc welded pressure vessels without butt straps. If that method could be successfully used in the United States it was time we could use and adopt it in this country. He urged, therefore, that any regulations for welding practice which might be drawn up should not be based on what we were doing at present. If they were a limit would be placed on future practice. From the same standpoint he urged that the proposed regulations should not restrict users to the employment of low-tensile steel, as suggested by Mr. Schuster. He hoped that the Institution would form a committee to study the subject. It was badly needed. Welding, he maintained, was not a discredited trade, but one with a great future before it. Some of the welding failures illustrated by the author failed, not because the vessels had been welded, but because they had been made of material little better than brown paper. Many people resorted to welding because it was cheap and because without it they could not compete against rival manufacturers. That attitude was a wrong one, and led to bad work and the use of poor materials. The correct methods of welding, the correct form of joints to employ, and the correct stresses to use required to be established by some authoritative body. Welding was a good process, which in some instances had been badly used, but which had a great future before it.

Dr. F. C. Lea remarked that a large amount of welding was being carried out in this country, but the conditions under which it was applied were chaotic and led to the incurrence of much danger. Fusion welding might be defined as that process of joining metal in which the joint was made by some material extraneous to the metal being united. Before we proceeded too far in the matter of laying down rules it ought to be recalled that there were several classes of vessels to be considered. There were vessels intended for holding air, oxygen, nitrogen, &c., under pressure. There were also vessels intended for holding noxious gases, such as chlorine and phosgene, accidents to which would cause not only the explosion of the vessels, but the liberation of dangerous substances. Could fusion welding be allowed at all for vessels of the second class? He suggested that some more generally secure form of welding should be used, such as water gas welding, in which no extraneous metal was employed and in which work was actually done on the weld as on a smith's weld. The efficiency of a water gas weld was very much higher than 50 per cent. We must not be content to think only in terms of fusion welding. The technique of water gas welding had been fairly fully worked out in this country, and the system was generally made use of for vessels designed to carry noxious gases. He fully agreed with the view that no specification should be drafted that would jeopardise future developments, but he submitted that it might be found desirable or necessary to stipulate the materials and processes to be used for particular purposes.

Mr. George Adamson said that the paper was full of very badly needed information. He supported the opinion that much of the ill-feeling against welding was to be ascribed, not to the employment of welding as welding, but to faulty design. It was possible, he thought, that 90 per cent. of the trouble arose from bad design and 10 per cent. from bad welding. A common argument against welding was that it was impossible to see what was inside the weld. The argument was not a good one, for it was equally impossible to see inside a riveted joint. The use of 26-ton material for welded vessels was, he submitted, a relic from fire welding. He had had very good results from the electric welding of 40-ton steel, but could not get a sound fire weld with the material. The author had erred on the safe side in drawing up his specification, but as welding had to gain the confidence of British engineers, Mr. Schuster's moderation was no doubt wise. He criticised the high efficiency assigned by the author to that form of end plate joint in which the end plate was flanged and had the lip of the barrel plate turned down against it before the welding was carried out. The joint was not ideal, because of the difficulty of knocking down the barrel plate and because the weld was applied right on the knuckle of the flanged end plate. The joint referred to by Mr. Adamson will be found illustrated in Fig. *h* in the diagram accompanying the proposed rules drawn up by Mr. Schuster and reprinted elsewhere in this issue.

Dr. G. A. Hankins, of the National Physical Laboratory, asked Mr. Schuster if he had had any experience of the methods of inspecting fusion welds advocated in the United States, such as the use of X-rays, vibration tests or the employment of the system evolved by Sperry for the detection of flaws in rails.* He supported the author in his views as to the need for ductility in the weld metal. It was important to have the maximum possible amount of ductility. To test it the Izod method gave more valuable results than an ordinary tensile test. On the question of fatigue tests on welds he remarked that a certain amount of work had been done, but that the specimens employed had mostly been carefully prepared and polished before being tested. In view of the well-known effect of surface conditions on the results of a fatigue test, he submitted that such tests on welds should be carried out on the specimens as received from the welder.

Mr. T. Fordyce said that the fusion welding of unfired pressure vessels had been before insurance engineers for many years. During the past ten years or so such vessels of every description made in all parts of the world had been placed before his company for insurance purposes. They had dealt with them, but had always felt the need for an authoritative code of rules for the design and use of the vessels. He had never encountered any justification for the view that all fusion welding must be bad. His experience was that it could give very good and useful results. Aluminium, monel metal, copper, and many other metals could all be satisfactorily welded by the fusion process. There was now in use in the North of England an all-welded marine boiler working at 180 lb., which had been in use without trouble for the past fifteen years. A word of caution was necessary as to the training of welders. It was quite impossible to train a welder in a few hours' time, as some claimed to be able to do. The rules given in the appendix to Mr. Schuster's paper had now been in use for over twelve months, and might well be made the basis for a more ambitious code.

Mr. P. L. Turner disputed any suggestion that might have been conveyed by Mr. Schuster's introductory remarks to the effect that continental people were more versed in welding than we were. Twenty years ago he was selling in Germany welded vessels made in this country. The Germans preferred to buy a British product and to pay a heavy duty on it, because of the superiority of British welding. He could also mention the fact that ten years ago British-made welded vessels, 10ft. in diameter, had been supplied to Trinity House for holding gas at 150 lb. pressure, and that they were still in service. We could, he thought, claim to be in the first rank so far as welded pressure vessels were concerned. The paper dealt only with unfired vessels. He hoped that in the not distant future the author would present another on fired pressure vessels. In Germany hundreds and thousands of boiler drums with welded seams were now in use, and he looked forward to the time when we could get welded boilers accepted in this country. In the manufacture of welded boiler drums their correct heat treatment for normalising and annealing was very important. With this correct heat treatment the efficiency of the joints could be as high as 90 per cent. The Board of Trade rule required a welded joint to be covered by a butt strap. It had been proved time and again in Germany that such straps were not necessary if the weld were properly designed and carried out. As a manufacturer, he would welcome the assistance of any insurance company that would undertake the insurance of welded drums and boilers.

Mr. J. K. Muir criticised the use of ordinary lap-welded joints. They should not, he said, be used for any purpose, and particularly for longitudinal seams. Had the author found any support for the commonly held view that the strength of a welded joint depended materially upon the welder who made it? If a vessel were welded by two welders, would he ever expect to find the efficiency of the joint at one end 80 per cent. and at the other only 60 per cent.? Mr. Schuster's investigation was the first impartial study of welding to be carried out in this country. His rules were, however, clearly stated to be tentative. In view of the improvement in the quality of welding which would result from the formulation and general adoption of standardised rules, he would suggest that the welding industry should itself undertake the task of producing such rules.

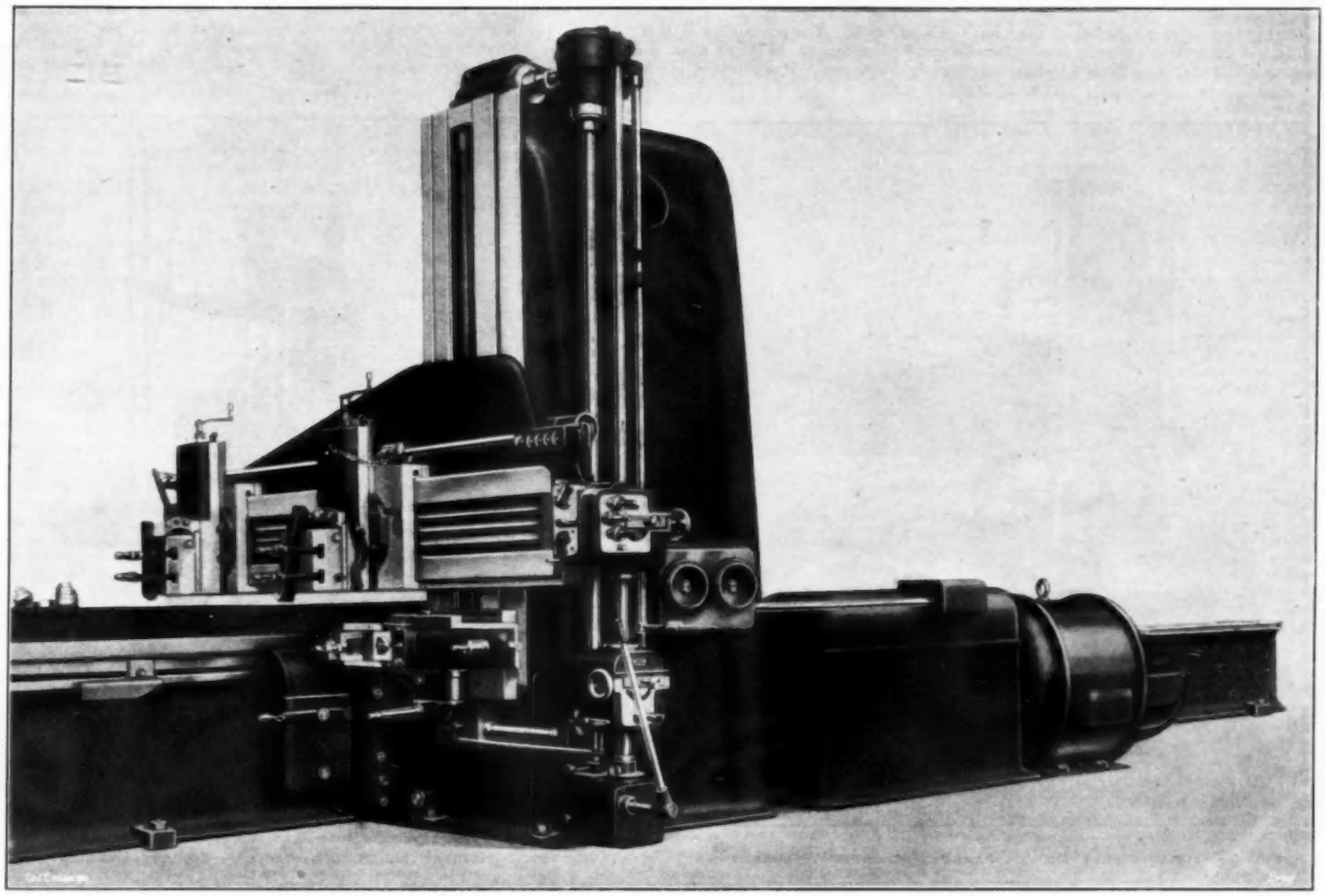
Mr. Ballantyne did not think that Mr. Schuster was sufficiently optimistic about welding. His suggested rules laid down a standard which was very much below that which could be realised by good welders. Mr. Thomas Clarkson supported the suggestion that the Institution should investigate the practice of welding, and proposed that it should institute a system of branding welds that would command the respect of insurance companies.

Mr. Schuster, replying to the discussion, said that it had been felt necessary to obtain the opinion of all grades of engineers on the question of welding pressure vessels in order to help his company in its work. He was particularly grateful to Mr. Pollard for suggesting that the Institution should take up the work which his company had begun. When a satisfactory code for unfired pressure vessels had been evolved, it would be possible to take up the question of welds for fired pressure vessels. He maintained that ductility in the weld metal was essential. It was useless to join metal having a 20 per cent. elongation by means of another metal having only 5 per cent. elongation. He could not agree with Dr. Paterson that welding for pressure vessels was not regarded with suspicion. Taking not a few selected engineers, but the general body, welding was at present undoubtedly regarded suspiciously. The question had been asked why he had suggested restricting the application of weldng to 26-ton metal. It was necessary to proceed slowly when a new set of rules was being drawn up. In the United States 22 to 30-ton steel was permitted, and in Switzerland 24 tons was the official figure. He agreed with Dr. Lea concerning the welding of vessels to contain noxious gases. It was doubtful if fusion welding was the best process to adopt for such vessels. Water gas welding was certainly capable of giving a much higher efficiency than the 50 per cent. which was the official maximum allowed for any form of weld. He believed in the use of water gas welding, wherever it could be applied, but it was doubtful if it could be employed for every type of vessel mentioned in the paper. The particular type of joint referred to by Mr. Adamson was undoubtedly defective in that it placed the weld on the knuckle of the flanged end. He did not really like the joint in spite of its high efficiency. He regarded it, however, not as a fusion welded joint, but as a mechanical lock. For circumferential joints butt

* The Sperry system referred to was described in The Engineer for May 10th, 1929.

HYDRAULICALLY-DRIVEN PLANING MACHINE AT LEIPZIG FAIR

H. A. WALDRICH, SIEGEN, ENGINEER



welds were undoubtedly best, and if the vessel was over 3ft. in diameter, transverse cover straps should be used. The lap welded joint was a miserable thing, and should not be used. There was undoubtedly a great variation in the efficiency of joints made by different welders, and it was because of that variation that it was necessary to rate the efficiency on the lowest quality of the workmanship. It was essential, in other words, to look at welding at its worst.

Time did not permit Mr. Schuster to reply further to the discussion.

The Technical Fair at Leipzig.

THE Annual Spring Fair at Leipzig has attained such dimensions of recent years that observation alone can hardly be relied on when comparing one Fair with its predecessors. An exhibition comprising many scores of separate buildings, in which about 10,000 manufacturing firms cover annually some 500 acres of floor space with goods of almost every imaginable kind, is far too vast for ordinary fluctuations in magnitude to be perceptible to a visitor. For evidence of growth or otherwise, one must depend on official statistics, which show that the Fair which opened on March 2nd last, housed 9570 exhibitors, a falling off of about 5 per cent. from the corresponding figures for last year. The floor space rented, namely, 191,500 square metres, was the same, the exhibitors therefore each occupying, on the average, slightly more than in 1929. Of the 9570 firms exhibiting, 8320 were German, the remainder belonging to twenty-five different nationalities. Amongst the latter Great Britain came eighth, with forty exhibitors, following Chechoslovakia, Austria, Japan, France, Italy, Denmark, and Switzerland, in the order named. Of these forty, eleven only were to be found in the Ring Messhaus, where it was hoped to concentrate a British Section, and even these were spread over three floors, so that anything in the nature of a National Section, such as organised by the Japanese, French, Italians, Danes, Poles, and others, was completely wanting so far as Great Britain was concerned. Indeed, to see the whole of the British exhibits, one would have had to visit ten different buildings in the city and three separate halls in the Technical Section of the Fair.

This fact indicates in some measure the varied nature of the displays by British firms, but the dispersion which it connotes made it quite an event to find a British stand at all. As to the contents of these stands, if we eliminate those devoted to apparatus for games, pottery, and glass exhibits, "fancy" and household goods, railway companies, propaganda, and so on, the remainder, which contained articles of engineering interest, were very few indeed in number. There were, in fact, so few in the Technical Section of the Fair that it is practicable to name them all, viz., Alred Herbert, Ltd., of Coventry; Platt Brothers and Co., Ltd., of Oldham; Rose Brothers, Ltd., of Gainsborough; James Mackie and Sons, Ltd., of Belfast; Green and Luxton, Ltd., of London; Henry F. Cockill and Sons, Ltd., of Manchester; and the Great Western Railway Company. To these alone it fell this year to represent British engineering work at Leipzig, and, even so, the railway company could only do it by inference. With a total of 2270 firms represented in the Technical Section of the Fair this year, it can hardly be said that British participation was overdone! What may be the benefits of exhibiting, only those firms who have tried it can say, but with an average attendance of about 180,000 visitors, of whom some 30,000 come from overseas, the possibilities of business would seem at least reasonable.

In this connection some very interesting statistics have been prepared by the Fair Authorities. The annual influx of visitors from different countries has been plotted for several years past, and on the sheet relating to each country have also been plotted the corresponding values of the German exports to that country. The pair of curves so obtained shows a really extraordinary parallelism between the number of visitors coming and the value of goods exported. We do not suggest that this striking correlation between visitors and exports has any bearing one way or the other on the question of a more adequate representation of British manufacturers at Leipzig, but what it does indicate most strongly is the great importance to our own export trade of encouraging, by all possible means, the influx of visitors to our own National Fair. The most effective way to do this would seem to be for our manufacturers to make it worth while for foreign buyers to come by supporting the British Fair as wholeheartedly as their German rivals support Leipzig.

We have on previous occasions described the general form of the Technical Fair at Leipzig, which is organised separately from the main Fair, with its own exhibition grounds containing sixteen large halls, comparable with anything of the kind in Europe. The contents may be divided broadly into three groups, namely, electro-technical exhibits, which occupied 540 stands; machinery, occupying 420 stands; and building materials, &c., with 320 stands. In spite of its numerical preponderance, the electro-technical section was by no means the most interesting, on account of the practical absence of heavy power station machinery. The magnitude of the display was due to the multitudinous stands devoted to electric fittings, wireless apparatus, &c. To the engineer, the real attraction of the Technical Fair consisted in the vast amount and variety of machinery displayed, and of this machinery, machine tools easily took pre-eminence. Once again the great hall of the German Association of Machine Tool Makers was filled with every kind of machine tool, nearly all actually working. There is no need to repeat the expression of our admiration, which must be shared by every visitor, for the organisation of this display. The green-carpeted aisles, named like streets, separating the blocks of neat and well-arranged stands; the total absence of division walls, partitions, or advertisements to obstruct the view; the discreet and uniform signposts at the corner of each stand, giving the stand number and the name of the firm; the admirable information cards to be taken by visitors, containing the leading particulars of each exhibit in uniform style, and so saving everybody's time and temper; and the technical information service for the benefit of any inquirer—all combined to leave a most favourable impression of the co-operative organising ability of the German machine tool industry.

The expense of such an annual show must be very great, for the transport across Germany and back of some of the largest tools ever built, and their erection, operation and dismantling cannot be done for nothing. One firm alone brought over 133 tons of machinery from Düsseldorf. The cumulative effect on foreign visitors of such shows is, however, unquestionable. Returning from the British Industries Fair, where not a machine tool is to be seen, and observing the annual display at Leipzig, they are not to be blamed if they consider the British tool-making industry as negligible in comparison with that of Germany. Though we are really far from that point, it can hardly be comforting to our own manufacturers to reflect that during the last three years, the value of machine tools exported by Germany has been very nearly four times the value of British tools exported. Indeed, the whole of the British tool exports during 1929 had a value only fractionally greater than that of the increase alone in the German exports during the same year. Germany is now the greatest tool exporting country in the world, and that the attainment of this position is largely due to the policy of the German Machine Tool Trade Association in respect of its show at Leipzig can hardly be disputed. Whatever its enterprise may cost it,

the expense would seem to have justified itself. Possibly a corresponding enterprise on the part of our own makers would have prevented them losing the £1,950,000 of British orders, which went abroad last year, to say nothing of the export trade that might have been gained by less reticence with regard to their products.

Regarding the Leipzig display of machine tools as a whole, it was difficult to note any particular new trend in design. Flanged motors built into the tools were the roll surface, when desired, is effected by gear mechanism, the old cam plate with its accompanying levers and rods, having been discarded. The grinding wheel spindle is supported by bearings on both sides, instead of being overhung as in many machines, and it is driven by rubber V belts, a change which has eliminated many causes of vibration and consequent bad work. The machine will deal with rolls up to a working length of 1700 mm. and up to a diameter of 800 mm. Push-button control provides a quick and maximum stroke of 550 mm., though the firm supplies machines on the same principle with strokes ranging from 250 mm. to 850 mm. By controlling the oil pressure, the cutting speed may be varied continuously from zero up to a maximum of 50 m. per minute, while the machine is running. This regulation does not affect the speed of the return stroke, which remains constant at 60 m. per minute. The motion of the shaper head is very smooth, as all gearing is eliminated, and reversal is effected without

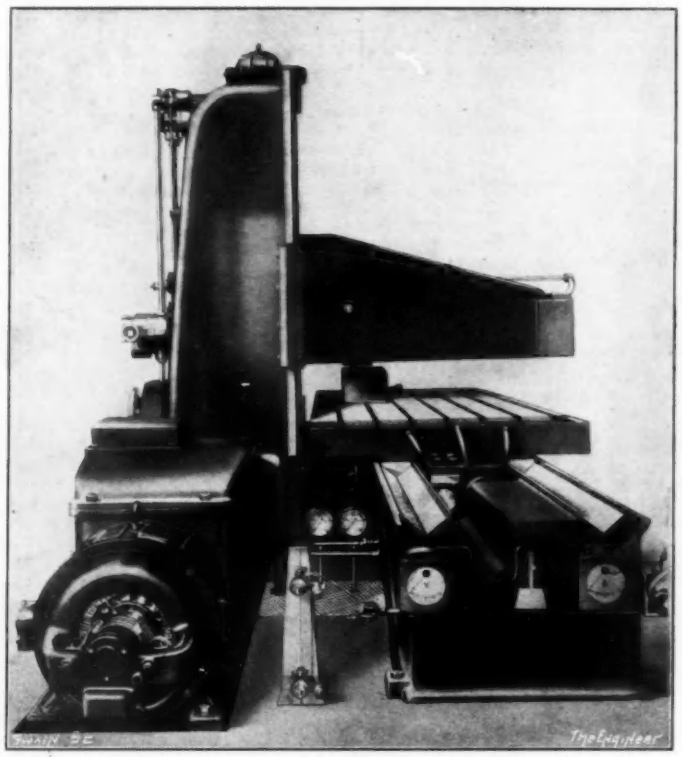


FIG. 1—HYDRAULICALLY-DRIVEN PLANING MACHINE—WALDRICH

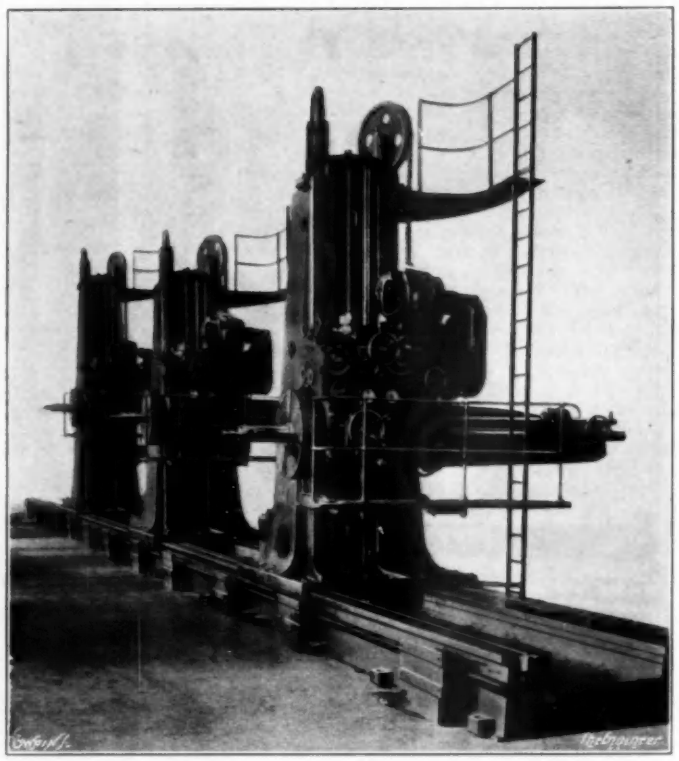


FIG. 2—HORIZONTAL BORING MACHINE—SCHIESS-DEFRIES

general practice, a number of separate motors being frequently found on a single machine. Grinding processes are also very largely favoured in Germany, to judge from the number of manufacturers who specialise in grinding machines. There also seems a tendency to adopt the hydraulic drive in place of a mechanical one, in the case of planing and shaping machines. The idea of a hydraulic drive for machine tools is, of course, not new. During the war, Mr. Philips, of Melksham, designed and built a number of lathes in which hydraulic power was used for moving the saddle and cross slides. With such lathes, girls turned out 9in. shells in one-third of the time allowed by the Ministry as the best standard practice on ordinary machines, the operators were not fatigued, and the breakages of tools and machines were negligible. The advantage of the hydraulic drive lies not only in its simplicity and power and smoothness, but mainly in the fact that the designed stress in any part cannot be exceeded. If the saddle or tool holder becomes jammed, or the tool will not cut for any reason, its motion simply stops, whereas with any mechanical drive something would have to give way.

Among the firms which have adopted the hydraulic drive are Messrs. H. A. Waldrich, of Siegen, who exhibited a large open-sided planer driven in this fashion. We illustrate this machine in Fig. 1 and on page 291. It is capable of dealing with work up to 4000 mm. in length, 1850 mm. in breadth, and 1300 mm. in height. The drive of the table in each direction is obtained by an independent single-acting hydraulic cylinder underneath it, in which oil pressure is maintained by a pump forming part of the machine. On the idle stroke of the table the working pressure is about 150 lb. per square inch, rising to a maximum of 1200 lb. per square inch on the cutting stroke. An infinitely variable cutting speed up to 60 m. per minute, combined with a return speed of 80 m. per minute, allow of a very high output of work on any class of material. Reversing is effected by valves controlled by adjustable table stops, and takes place without shock at the highest speeds. The feed gear is actuated by a small independent hydraulic cylinder, controlled also by the movement of the table. The machine is driven by an ordinary constant-speed, three-phase motor, coupled directly to the oil pump, the use of hydraulic transmission permitting any kind of commercial motor to be employed, without considerations of speed regulation or reversing.

Messrs. H. A. Waldrich also showed a planing machine of more usual type, but notable for the rigid and practical manner in which the cross slide is attached to the standards. A new design of roll grinding machine was also to be seen on their stand, permitting of cylindrical convex and concave grinding of roll barrels, as well as the grinding of the roll necks. The cambering of the easy means of moving the grinding wheel towards and from the work. A special motor for this motion is fitted on the grinding slide.

The application of hydraulic power to the operation of shaping machines was to be seen on the stand of Messrs. Lange and Geilen, of Halle (Saale). In one type of machine the oil pressure system constitutes merely a speed-controlling element between the electric motor and a crank and slotted lever mechanism. A rotary oil pump is driven by the electric motor, and the oil under pressure drives an oil motor, the shaft of which is geared to the main crank shaft of the machine. The arrangement permits of an easy speed control independently of the electric motor, which may therefore be of any commercial type. Besides this machine, Messrs. Lange and Geilen had on their stand another model in which a hydraulic drive is employed directly for the actuation of the shaper head and for the control of the table movements. The machine exhibited had a shock. The normal oil pressure is 60 kilos. per square centimetre, or about 900 lb. per square inch, and the force which can be applied to the tool is about 2·2 tons. Since, by the principle of the machine, this force cannot be exceeded, there is an automatic safeguard against breakages by overloading.

As usual at Leipzig, the stand of Messrs. Schiess-Defries, of Düsseldorf, contained a number of very imposing machines. The largest exhibited this year was a horizontal boring and milling machine, with travel-

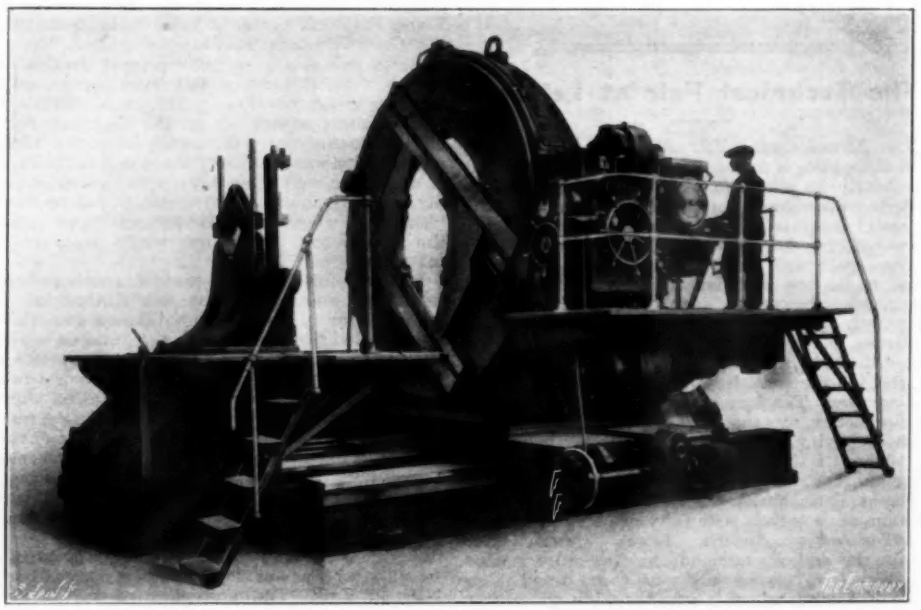


FIG. 3—CRANK-PIN TURNING MACHINE—SCHIESS-DEFRIES

ling standard. Exactly similar to that illustrated in Fig. 2, except that only one standard on a correspondingly reduced length of bed was present at the Exhibition, the machine dominated the tools in its immediate neighbourhood by its dimensions. The boring spindle has a diameter of 180 mm., and a vertical travel of 4000 mm. The length of the bed is 12,000 mm., giving a travel of 10,000 mm. to the standard. The driving motor, of the direct-current type, with a speed variation of 1 to 3 in either direc-

tion, is carried on the saddle, and transmits its power through gearing. Thus, the power is developed as close as possible to the work. All the wheels and levers required for the complete manipulation of the machine are brought together conveniently for the operator as he is watching the work from his platform. The control of the motor is effected by press buttons, while a complete automatic oiling system, and safety couplings on all important motions protect the machine from negligence or inadvertence on the part of the operator. The motor is further protected by automatic overload switches. The whole machine weighs about 50 tons.

Another striking machine by the same makers, which was shown at work on their stand, was the crank pin turning machine illustrated in Fig. 3, which has been built to a Russian order. The tool head has a clear opening of 1500 mm. diameter. The bed is 6000 mm. long and 2000 mm. broad, and the weight of the machine is no less than 35 tons. The head is driven by an electric motor with gear transmission. Another motor is provided for quick traverse of the head along the ways. Both motors are controlled by press buttons, which, together with all apparatus for the complete operation of the machine, are situated as conveniently as possible for the man in charge of the work. All gearing is, of course, completely enclosed, cut steel gear being used where the duty is heavy. Ground shafts running in bronze bearings are employed for heavy work, the axial thrusts being taken by ball bearings. Automatic lubrication by oil under pressure is provided throughout.

The application of hydraulic power to an otherwise mechanical riveting machine is exemplified by the machine we illustrate in Fig. 5, exhibited also by Messrs. Schiess-Defries. The machine is essentially a portable one, to be used suspended from a crane, but it can equally well serve as a stationary machine by bolting it to a foot, as shown in the engraving. It weighs complete 1600 kilos. Being balanced about the point of the attachment of the stirrup, it can deal with work either vertical, horizontal or inclined at any angle. Power is furnished by an electric motor built into the framing. The motor shaft drives a worm wheel, the ends of the shaft of this wheel being fitted with cranks which operate the toggle mechanism shown. The pressure due to the toggle action of the lever system is applied to a ram in a hydraulic cylinder, and thus transmitted by oil pressure to the riveting spindle. Machines of the kind are built in six sizes, exercising a riveting pressure ranging from 17 to 130 tons, and capable of closing rivets from 13 mm. to 40 mm. diameter for boiler work. The model illustrated is built to deal with 22 mm. rivets in construction work or 19 mm. rivets in boiler work, the riveting pressure being 30 tons. It makes eighteen strokes per minute, and requires about 2 H.P. A manometer indicates the closing pressure on the rivet, and, if desired, a graphic recorder can be attached when the supervision of the work is of particular importance. It should be noted that no fine adjustment of the machine to the exact rivet length is required, as the proper closing pressure will be applied in all cases.

Alfred Herbert, Ltd., of Coventry, the only firm of British machine tool makers exhibiting at Leipzig, acted on the principle that if a thing is worth doing at all, it is worth doing well, so, not only was its stand ample in size, but it was equipped with something like a dozen machines of various kinds, all in working order and arranged for the demonstration of actual production times. It was, moreover, organised for business, with literature in the language of the country and attendants capable of conversing in that language. The stand was not in the great machinery hall, as this hall belongs to members of the German Machine Tool Trade Association, but it perhaps gained a greater prominence by being in an adjacent building, half of which housed the overflow from the main hall, as well as providing space for makers outside the Association. Among the machines shown was a No. 3 Auto-Lathe, illustrated in Fig. 4. This lathe is replacing turret lathes, in cases where a sufficient number of similar articles can be put in hand at one time, as it gives a very high output per foot of floor space, with a very low labour cost per piece. It is specially suitable for small chuck work, which requires turning, boring, facing, or threading. All operations, except chucking, are automatic.

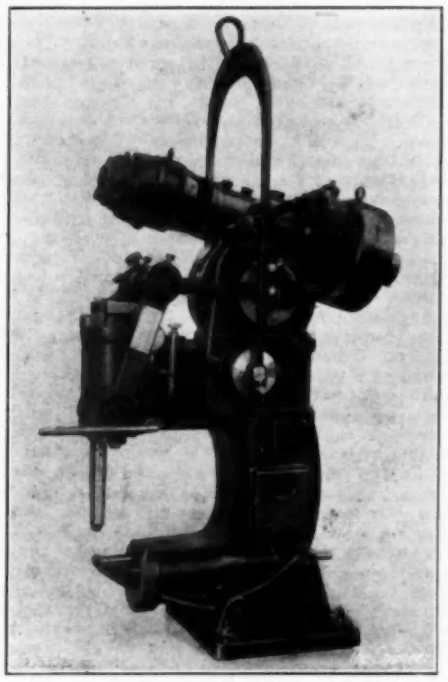


FIG. 5—ELECTRO-HYDRAULIC RIVETING MACHINE

The machine illustrated will swing work up to 8½in. diameter, the capstan has a working stroke of 6½in., and the distance from the flange of the spindle to the capstan face is 11in. as a minimum and 20½in. as a maximum. As examples of the work the lathe will do, it may be mentioned that malleable iron castings for the front wheel hubs of motor cars can be machined all over, and the bore reamed to size in 12 minutes; differential wheel blanks for motor cars can be machined all over from steel forgings in 6¾ minutes each; and change speed gear blanks, 3 11/16 in. diameter, machined all over from chrome-nickel steel stampings in 11 minutes each. In this connection, it should be mentioned as a good feature of this exhibit that a wide range of actual machinery parts were shown, and that the firm stated that it was prepared to guarantee actual times of production by the use of its machines.

Reference has already been made to the development of hydraulically operated machine tools, and we now illustrate in Fig. 6 an hydraulic open-side planer exhibited by Messrs. Billeter and Klunz, of Aschersleben. The main motor drives an oil pump, which forces oil at a maximum pressure of about 1200 lb., alternately into two cylinders underneath the table, the ram of each cylinder being attached to the table. There is thus no gearing of any kind in connection with the drive of the table. The table speed on the working stroke is variable from 2 m. to 40 m. per minute, and on the back stroke from 2 m. to 60 m. per minute. The machine illustrated has a table 1300 mm. wide by 3000 mm. long, and will machine work up to 1500 mm. wide and 1100 mm. high. The force tending to drive the table is about 6 tons, the normal cutting speed is from 170 mm. to 250 mm. per second, and the return speed 450 mm. per second. The total weight of the machine is about 16 tons. Its operation is extremely simple. By moving the starting lever into the working position the machine starts and continues to work automatically, its speed being regulated at will by a valve. The table can be stopped by the same valve, the motor and oil pump being left running, if desired.

The vertical boring mill, illustrated in Fig. 7, was exhibited by Messrs. Schiess-Defries, of Düsseldorf. It has a table of 1000 mm. diameter and is throughout of very heavy construction, designed to take full advantage of the possibilities of high-speed steel. Work up to 1050 mm. diameter can be machined normally, or up to 1300 mm. diameter by lowering the tool slide on the standard. A motor of 40 H.P. is used to drive the machine. Twelve table speeds are provided, ranging from 6 to 100 revolutions per minute. The large diameter of the table support and the great breadth of all sliding surfaces are noteworthy. The tool slide can be set to slant at any angle up to 45 deg. in either direction. The turret slide is of cast steel, and is balanced by a counterweight. Full forced lubrication is supplied to the working parts. Another speciality of Messrs. Schiess-Defries is the manufacture of comparatively small pillar grinders, for dressing cutting tools. One type of such machines, which they exhibited at Leipzig, is the grinder illustrated in Fig. 8. Its special function is the grinding of hollow lips, to give top rake to lathe and other tools. The grinding wheel is mounted directly on the spindle of a little electric motor. The arrangement can be swung round on the table, so as to enable both right and left-handed tools to be ground. The slides, as can be seen, are thoroughly protected from injury by dust. The reciprocation of the grinding head is effected by a separate small motor, acting through a crank and connecting-rod mechanism. The machine is arranged for either wet or dry grinding; in the former case water is supplied by means of a small electrically driven pump.

Regarding the machine tool exhibition generally, one was struck by the number of firms manufacturing grinding machines of one kind or another and by the apparently increasing application of grinding methods. Messrs. Billeter and Klunz, of Aschersleben, have developed a machine having, at first glance, a slight resemblance to an open-side planer, but differing from the latter in the fact that the standard with its overhanging arm travels to and fro along the bed. The purpose of this machine is to grind up the ways of lathe beds, the adjustments of the grinding wheel being such that all types of ways at all angles of inclination can be dealt with. The bed of the grinding machine itself is protected from dust by a sort of concertina covering, which collapses and expands as the standard travels along, the slides on each side of the standard being thus completely concealed. Another grinding machine which attracted much attention was exhibited by Naxos-Union, of Frankfort-on-Main. It is of the standard planing machine type, the work being placed on the table and traversed under a large central grinding wheel on a vertical spindle. The grinding wheel is of segmental construction, 1400 mm. diameter, and is driven by two vertical motors developing together 60 B.H.P. In spite of the development of grinding, however, the manufacturers of machine tools do not themselves seem yet fully alive to its possibilities. Shafts, of course, are practically always ground, and so probably are the round columns, such as those embodied in

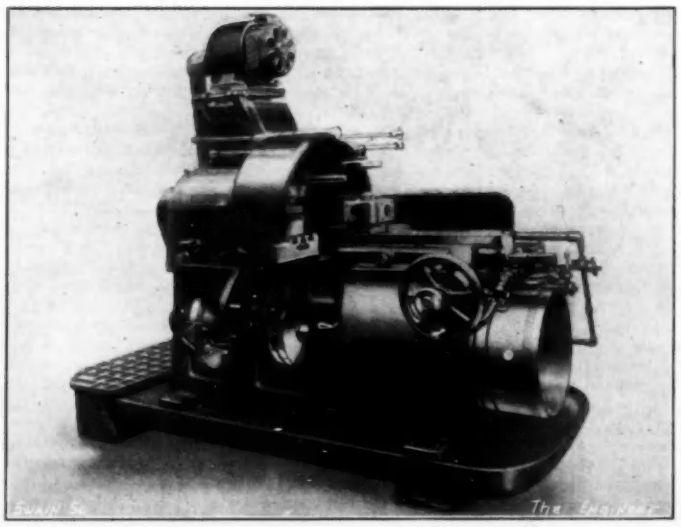


FIG. 4—NO. 3 AUTO-LATHE—ALFRED HERBERT

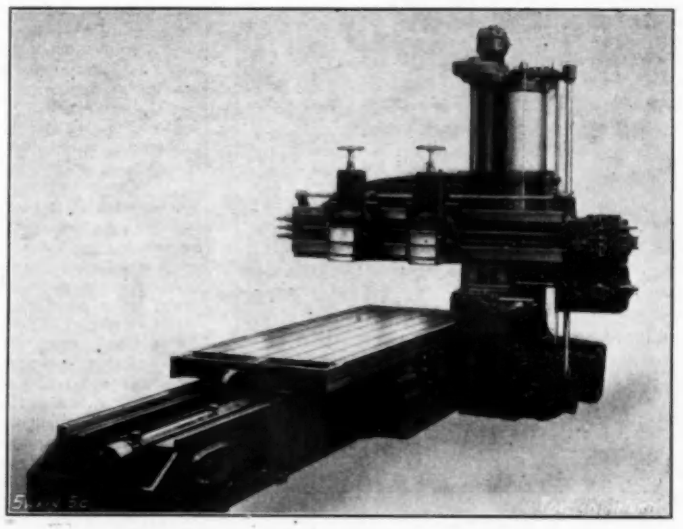


FIG. 6—HYDRAULIC PLANING MACHINE—BILLETER AND KLUNZ

radial drilling machines. But when it comes to flat surfaces, the position is quite different. One can find makers who finish such surfaces by grinding, one firm showing a 12in. lathe with all flat surfaces, including the ways of a 10ft. bed, finished in that way; but they are few and far between. Hand scraping is practically universal. There may be something in the argument that the slight irregularity of hand-scraped surfaces tends to hold the oil and thus to assist lubrication, but this something is probably extremely small. What is a more likely reason for the continued prevalence of scraping is the implied, though not necessarily realised, accuracy of a hand-scraped surface. The appearance, moreover, is

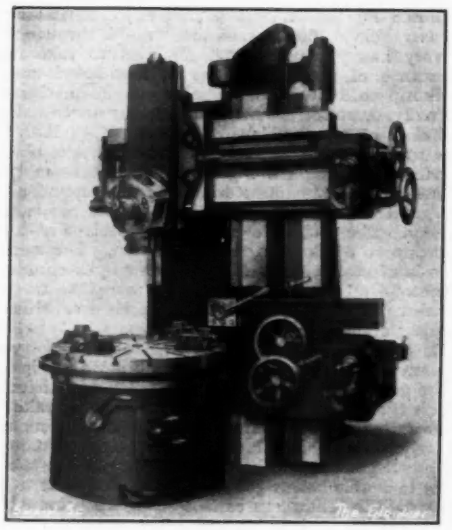


FIG. 7—BORING MILL—SCHIESS-DEFRIES

pleasing, and scraping has for so long been associated with the production of accurately flat surfaces that the custom is likely to die hard. It is said that Whitworth, the reputed inventor of the three-surface-plate method of developing a plane surface, and who therefore fully realised what such a surface was, was an early exponent of ground slides for machine tools, but the prejudice in favour of scraping, which his own work had created, was so strong that he was compelled to add scraper marks to satisfy purchasers. It may be mentioned that one firm of British lathe makers has for some time finished all its beds by grinding, producing thereby a machine which on both price and quality can compete successfully with

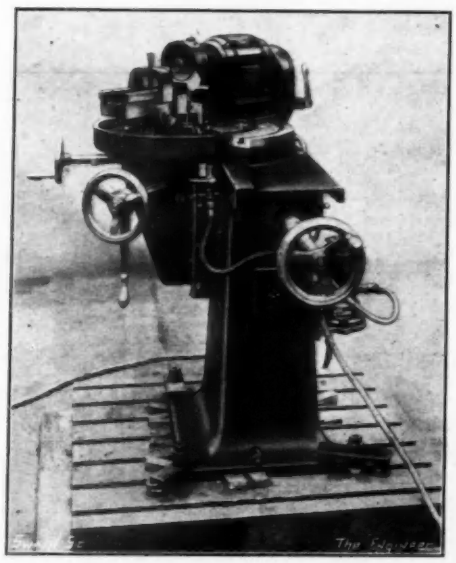


FIG. 8—TOOL GRINDING MACHINE

continental manufacturers, even in their own market.

Another feature which one could hardly help noticing was the multiplicity of electric motors on many machines. It may be said that the employment of the flanged motor, the frame of which is bolted to the machine and virtually forms part of it, is almost universal. But instead of regarding a driving motor so fitted as a central source from which power is transmitted for the various functions of the machine, the practice is increasing of fitting a special motor for almost every function. We counted, for example, no less than six separate motors on a large open-side planer. The first, or main, motor, served to operate the table, a second motor raised and lowered the arm of the machine, two more served each to traverse one of the tool boxes on the arm, another raised and lowered the tool box on the standard, and, finally, another little one drove the lubricating oil pump. Design of this kind certainly gives an extreme degree of independence to the various motions and avoids considerable mechanical complications, but it can, possibly, be carried to excess. The whole question turns largely on the relative cost of the two alternatives, and if the multiplication of motors is found to be as cheap, or only very slightly dearer, than the shafts, bearings, gear wheels and other details which their presence eliminates, it is likely that the practice will become general. It certainly tends to a neat and convenient machine, and facilitates the use of "push-button control," which is becoming such a feature of large modern machine tools.

In connection with power generating machinery, Diesel engines certainly occupied the first place, though they appeared hardly so prominent as in previous years. The largest on view was a 350 H.P., six-cylinder, four-cycle engine, by Krupp, running at 300 revolutions per minute, though other makers showed engines of considerable size. The Maschinen Fabrik Augsburg-Nürnberg Company exhibited a 50-kW Diesel driven generator, arranged to come automatically into operation, should the public lighting supply fail for any cause. The utility of such a stand-by in the case of hospitals, public institutions of all kinds, theatres, &c., is obvious. Steam fittings were numerous, and the employment of higher pressures on power stations was fully reflected in the valves, gauges, &c., which were to be seen. A very large number of firms showed water gauges for high and extra-high pressure boilers, the almost universal design being a water column visible through a thick plate glass front. We write the word "visible" with a little reluctance, for the designers in nearly every case seemed to have wantonly detracted from visibility. The common practice was to fasten on the metal cover, through a slot in which the glass was to be seen, by a very large number of bolts. Sometimes there were a dozen or so bolts on each side of the slot. For some reason, with only one single exception, as far as we noticed, among the scores of gauges shown the bolt heads or nuts projected in serried rows above the surface of the metal, half hiding the glass from the view of anyone not exactly in front of it, and, in any event, needlessly distracting the attention from the only thing it was the function of the gauge to show. Furthermore, the "flare" of the slots might have generally been made considerably greater with no loss of strength and with advantage to visibility. Although we have emphasised these defects, it must not be considered that they are the monoploy of German practice, for we have observed a similar want of common sense on the part of British makers of such fittings.

Among the pumping machinery, an ingenious device for getting water out of a well by a centrifugal pump at the surface, in cases where the suction lift is beyond the capacity of any ordinary arrangement, was exhibited by Messrs. Siemen and Hinsch, of Itzehoe (Holstein). The pump is charged from a tank, and delivered its water at high velocity through a pipe descending the well. This pipe terminates in an injector under the water in the well. By the action of the injector, more water than descends into the well is forced up the delivery pipe, so that there is a net supply at the surface of the well. The system is in considerable use, and appears likely to be a desirable alternative to the practice of putting running machinery down a well, where it is not readily accessible. There is indeed nothing in the well but the up and down pipes and the small injector connecting them, the pump and electric motor being housed conveniently at the surface.

One of the interesting features of the Leipzig Technical Fair is the presence of machines which are rarely seen except by those engaged in certain specialised industries. Last year, for example, the visitor could see the manufacture of wire netting, a commonplace enough product, but one which must often have puzzled thoughtful people as to how it could be made. This year one could watch the manufacture of barbed wire, the raw material being four coils of galvanised wire, two of which form the strands, while the other two are previously twisted round one of the strands and the ends cut off, to form the four points so familiar and so effective in rendering a fence unpleasant to negotiate. Then, again, the visitor could see the manufacture of "french" nails from a continuous coil of wire, the cutting-off, heading and pointing being done at such a speed, however, that it was impossible for the eye to follow the motions of the machine. Textile machinery, too, always attracts crowds of curious watchers, and the display of such machinery this year was far greater than ever before. The only British textile machinery makers present were Platt Brothers, Ltd., of Oldham, who had a considerably larger exhibit than last year. Swiss makers were very prominent, and, as might be imagined, the artificial silk industry was well represented. Among specialised machines may be mentioned the apparatus for packing chocolates, caramels, and other sweetmeats, manufactured by Rose Brothers, of Gainsborough, a firm which exhibits regularly at the Fair. The soldering machines for tin cans, shown by Green and Luxton, Ltd., of Westminster Bridge-road, London, may also be included among machines a little out of the ordinary.

The Institute of Metals.*

PRESIDENTIAL ADDRESS BY R. SELIGMAN, Ph.nat.D.

When I look back over the thirty years which have passed since I left the university to take up industrial work, it seems to me that my whole working life has been devoted to the one object of transmitting the lessons learned from the distinguished scientists who were my teachers to a number of industries in which scientific methods of thinking and working have, until recently, made but little headway. Such an experience and the further lessons learned in its course might well form the subject of a presidential address. It seems to me, however, that at the present moment the Institute is faced by a problem which is great enough to demand that we devote the time at our disposal to its consideration. I prefer, therefore, to examine, as best I can, the new obligations imposed upon us by the fact, gratifying in the highest degree, that our Institute, in the short space of twenty years, has developed from a small body of English enthusiasts into an international institution, with a membership spread all over the civilised world. For our very success has brought in its train new problems which must be solved, new duties which must be discharged, new difficulties which must be overcome, if we are to maintain and extend the splendid work which those who founded the Institute and those who have thus far carried it on, have so admirably performed.

It is well known to us all that of our total membership, more than one-third is resident abroad, many in British Dominions overseas, but by far the greater part in countries which owe no allegiance to the British Crown. Moreover, the proportion of overseas members is growing rapidly—a fact which we must all welcome if we have at heart the welding together of all those who ply our craft, irrespective of their origins or their habitations. However welcome such a development may be, it seems obvious that it must, sooner or later, lead to modifications in our structure, in our very ways of thought, and it behoves us not to let such changes take us unawares.

What is the nature of the problem as it affects us? Clearly, it is of the same nature as that connected with our home local sections, but greatly magnified by such factors as distance, differences of language, differences of education, and, above all, those differences of outlook characteristic of the different nations. Our problem is complicated still further by the fact that we have to deal frequently with bodies of our members who are attached to other and not very different organisations in their own countries, and that it is essential for us to act so that while we secure and maintain their adherence to our Institute, and ensure that they bring to us the strength and driving power which we shall always need, we do nothing which shall even bear the semblance of attempting to wean them from their allegiance to their own national institutions.

Just as with our home local sections, we shall be faced more and more insistently with the necessity to devise means by which we at the centre can be kept in regular touch with the flow of opinion among these distant bodies of our membership, by which we can keep them informed of what is going on among ourselves, and, if our work is to be truly constructive and enduring, to see to it that such information circulates from one section to another and not only between centre and periphery.

For as I see it—and here I speak, of course, for myself alone—our objective in the future will no longer be confined to the dissemination of non-ferrous metallurgical doctrine, but will include the creation of a solid body of such metallurgical opinon throughout the world; the bringing into unison of all the different elements which go to form such a body of opinion, ourselves playing the honourable part of the cement which shall bind the whole together.

Now it is clear that the problem is one of great complexity, and that it will require much earnest thought before a satisfactory solution can be arrived at. Moreover, we shall have to think on broad-minded lines, unselfishly, and with minds attuned to the ways of thought of many peoples other than our own—attuned, in fact, to those world movements which are so prominent and auspicious a symptom of the day.

You will not expect from me a ready-made solution for a problem of such magnitude, and, indeed, a solution arrived at by any one individual is not in the least likely to be either satisfactory or permanent. We shall have to hammer it out in council with one another, and shall require the help of all and sundry in our difficult task.

It may, however, be opportune to examine one or two of the agencies which are already at work in the direction in which it seems we ought to go, and that, with your permission, I propose to do. If, in the course of this examination, I suggest one or two ways in which these agencies might be strengthened, such suggestions are meant to be only provocative of thought and discussion, and I would beg you, and especially my fellow-members of Council upon whom will fall the burden of solving the problems before us, to regard them only as such.

At the outset, let me refer to the conference now taking place under the chairmanship of the immediate past-President, which has the co-ordination of

* Abridged.

research in various countries for its object. This movement was initiated by Dr. Rosenhain at a dinner given in our honour by the Deutsche Gesellschaft für Metallkunde at Düsseldorf, and received an immediate and hearty welcome from the metallurgists of many nations there assembled. It was thought that it would be possible to conduct the deliberations of this conference under the ægis of our Institute, but it soon appeared that this was at the moment impracticable; and though Dr. Rosenhain and I very much regretted this fact, we both saw the force of the objection raised. Therefore, we felt justified none the less in pledging the full assistance of the Institute—a pledge which has since been confirmed by the unanimous vote of the Council.

For the present, this movement is designed, I believe, to provide means for keeping those engaged on non-ferrous research in the various countries informed as to what is going on in other countries, and so to prevent unnecessary overlapping and the irritation sometimes caused when work done in one country is apparently ignored by the scientists of another.

Such a movement seems to be full of promise, provided only that its authors recognise the limitations which the conditions of the day impose upon it.

They must recognise, to give only one example, that with the organisation of industry as it is emerging from the regrouping and reconstitution which is now in progress, there are arising research bodies attached to the great combines, which are, themselves, doing a great deal of the work—even fundamental research—which heretofore has been within the special field of individuals and the universities. With the best will in the world, such bodies will, in many cases, be prevented from communicating their plans to others. It would often be quite enough for an astute commercial rival to know that a certain laboratory was proposing to work on a subject, to make him realise that in that direction some great technical prize was awaiting him, and for reasons such as this it will be thought necessary to keep plans secret as long as possible.

If this and similar limitations of the moment are recognised from the start, we can confidently look for great benefits from Dr. Rosenhain's committee, and we may hope that before our present meeting ends he will be able to tell us that it is on the way to permanent establishment with its immediate objectives well in view.

A second agency which is capable of helping our cause forward, and rapidly at that, is the body of men distinguished in one branch or another of our art who, in many countries, are co-operating with us in promoting the objects for which we exist. I refer, of course, to the Honorary Correspondents to the Council, with whom we have now, to quote the poet, "put a girdle round about the earth," for in no fewer than fourteen countries are we fortunate enough to be represented in this manner.

Here, too, there is work to be done if we are to take full advantage of this unique company of helpers. Obviously, some of the steps in course of preparation and some of the suggestions made for associating our home local sections more closely with our work, can find application here; notably, the regular dissemination of news to our distant friends, to which I have already referred, should prove welcome and helpful. On the other hand it will obviously be impracticable to secure the personal contact which is so desirable, and, in the case of our home local sections, possible. It is striking, however, on looking at the distribution of our overseas membership, to see how many cases there are where considerable numbers reside in the same city, or at least within closer distance of one another than many of our London members travel daily between their homes and their work. There are ten or more places where groups of twenty to thirty or more members could readily foregather, and it may be asked whether it would not be possible to extend the local section idea to such places and so to secure regular meetings of our overseas members among themselves. Twenty is not a large number for such a purpose, but it is one of the great advantages of a local section that it need not be limited to full members of the Institute. On the contrary, we welcome to the meetings of these sections associates who are frequently young men not yet able to defray the cost of full membershipship, but to whom we look with confidence for the recruits of future years. Twenty regular members, if keen and active, would be a splendid nucleus for a section so composed, and such a section should be able to do excellent work, not only for its own members, but for the Institute at large as well.

There is one further advantage attached to association with a local section to which I have not yet referred, but which might, by a slight modification of our procedure, be made particularly helpful to overseas members. Papers of outstanding merit read before a local section can already be accepted for printing in our *Journal*. There seems to be no reason why such papers should not also be presented for discussion at our general meetings, provided, of course, that they have not been published in the interval and in other respects satisfy the requirements of the Publications Committee. This would not only encourage the presenting of original work to the local sections, but such a privilege should be especially helpful to young authors who would have gained experience by the discussion in the local section, and should, therefore, be able to revise their communications in any direction which that discussion indicated as being desirable.

Again, there seems to be no reason why the process of co-operation with the local branches of other and kindred societies, already a notable and highly successful feature of some of our home sections, should not be applied to the new sections which I should so much like to see spring from these groups of our overseas members. If such sections could be formed and the Council's Honorary Correspondents be supported by local committees, we should find it much easier to reach our members, however distant from us, to help them by securing that they were kept in touch with metallurgical thought throughout the world, and to secure from them new thoughts, new views, and therefore added strength for the performance of our task.

And now I come to the greatest of all our possessions, the readiest and most successful means by which we bind our scattered membership together—our *Journal*. They built truly and well who founded that great organ of metallurgical progress, and it is safe to say that to it, and therefore to them, we owe by far the greatest part of the success in which we rejoice to-day.

Believing this very whole-heartedly, I feel, nevertheless, that even here modifications of policy and practice will be called for, if our *Journal* is to play the same great part in the new world we see opening before us, as it has done and is doing in a world which is passing away. He would be a brave, almost a foolhardy, man who would recommend any far-reaching change in an instrument so perfectly adapted to its great purpose as is the section of our *Journal* which is devoted to a record of the original work of our members, and I certainly do not intend to propose any such change. Rather am I concerned to ward off a tendency which, if not kept in rigid control, may lead to deterioration where deterioration would be fatal to our interests and the interests we serve.

My concern is lest in our anxiety to encourage what are called "practical" papers, we should go too far, and so discourage those who provide us with papers on what we class as the purely scientific side of our subject. It is a matter of no small difficulty to keep a correct balance between these two branches, and yet it is highly important that we should maintain such a balance. From its earliest days the Institute has prided itself upon its duel function—that is to say, upon providing a forum in which the highest grade of purely scientific work can be presented and discussed, and, at the same time, a meeting place for those who have the daily task of carrying on the industry to which we are all attached in one capacity or another. It has been felt that only in this way could the Institute fulfil its task of serving both science and industry.

That task remains our task, unchanged; but is it not possible that industry of to-day, and still more industry of to-morrow, may call for different services from those we gave it yesterday? I think very strongly that it will—that the changes which we see going on around us, the grouping of industries in great national units equipped with means of carrying on research which make the means at our disposal twenty years ago seem elementary, the formation of research associations, the initation of co-operative research, not only in this or that country, but on international lines, are completely altering the perspective in which we shall have to view this subject.

At present we are in a state of transition, but surely the time is not far distant when those engaged in industry will find that their interests are not best served by papers dealing only with the severely practical details of the processes with which they are concerned. There will always be room and there will always be need for "practical" papers, which tell of difficulties encountered or indicate problems awaiting investigation, and, to my mind, there is no more valuable a contribution which the industrialist can make than to tell those who are engaged on pure reaserch work where such problems lie. But if there is one lesson which thirty years of industrial work have taught me, it is that my need is for the fundamental facts at the root of any problem on which I am engaged, and that, given these, their application to my own problem should be my share towards its solution. And so it seems that, if not to-day then to-morrow, the industrialist will call upon us more and more to devote our resources to the publication of the results of pure research rather than of the practical details of his art.

Therefore, I close my remarks with two appeals. To the scientists, and the scientists of all nations, I appeal to continue and extend the use of our *Journal* as the vehicle by which they transmit the results of their researches to the world. To the practitioners, I appeal to recognise that by supporting us and so making it possible for us to publish those researches they are helping themselves far more than by insisting on an undue preportion of "practical" papers. By this means can they best learn and help their colleagues to learn those fundamental facts upon which it is their own duty to base the ordered progress of their industry.

Where we enter the realms of pure science, nationality ceases to exist, and, as the poet says, "we know no border, no breed nor birth." In those realms, therefore, we can all work together, untroubled by competition, except for the advancement of our common cause, or by jealousy except of anything that may hinder the advancement of the art, of which we are all, according to our measure, the servants.

The Restoration of Tokio.

(By our own Correspondent in Tokio.)

ON September 3rd, 1923, less than two days after the first shock of earthquake which started the fires that destroyed the most valuable half of the city of Tokio, the Prince Regent summoned the Premier to his presence, and gave orders which resolved the serious doubts assailing the public mind—was Tokio to remain, or not to remain, the capital of the empire. Opinions were being freely expressed in the newspapers in favour of a return to the old capital, Kioto, to an area comparatively free from earthquake; and the recognition was general that Tokio was in the very centre of the volcanic zone, an area subject to frequent shock, and never free from vibration. Seismology as a science was unknown in the days 400 years ago when a clan chieftain selected the site for the erection of a fortress, now the Imperial Palace.

Immediately after the Premier's visit to the palace an Imperial Rescript was issued, which stated that Tokio had not lost its position as capital of the empire, and that it was to be rehabilitated, by which was meant not only the restoration of the capital to its former condition, but its extension, development, and improvement, so that it would be in every way worthy of the capital of the Empire of Japan.

The city was still being subject to hourly shocks of earthquake; fire was still raging; the streets on the rim of the burning area, and all open spaces, were packed with people, who lived as they could. Mercifully, it was summer-time, and the air was warm, lessening in some degree the suffering and loss of life that would have been caused had the calamity occurred later in the year.

Absolutely chaotic conditions prevailed. The police were helpless, since all communications were destroyed, and to disciplined soldiery must be given the credit for restoring and maintaining some semblance of order. For days the city was in peril from bands of so-called "vigilantes," who were a law to themselves and became a public menace, attacking wayfarers at night and killing some hundreds of innocent people.

In the midst of this public turmoil the authorities worked feverishly, first erecting huge barracks for the accommodation of the police and the Government departments, for only the Foreign, Navy and War Departments were outside the destroyed area. In obedience to the Imperial decree, there was organised the Commission of Restoration, a body vested with unlimited powers, which immediately created a Bureau of Reconstruction, the work of which, after seven long years, is now nearing completion. Weeks of the most intense destructive activity followed, companies of soldiers dynamiting the foundations of great buildings, the dull reports of which were heard throughout the day and night; myriads of people scraped ruins for belongings, for treasure; bands of men attacked skeletons of tramcars burned in their tracks, their iron frames red with rust. An inferno of disorder preliminary to orderly rebuilding.

And this rebuilding is accomplished. The foundations are finished—sewers laid, streets replanned and paved; spaces reserved for large and small parks; hundreds of new bridges, big and little; railways newly laid, railway stations reconstructed, more than a score. A great achievement, made possible only by earthquake and fire.

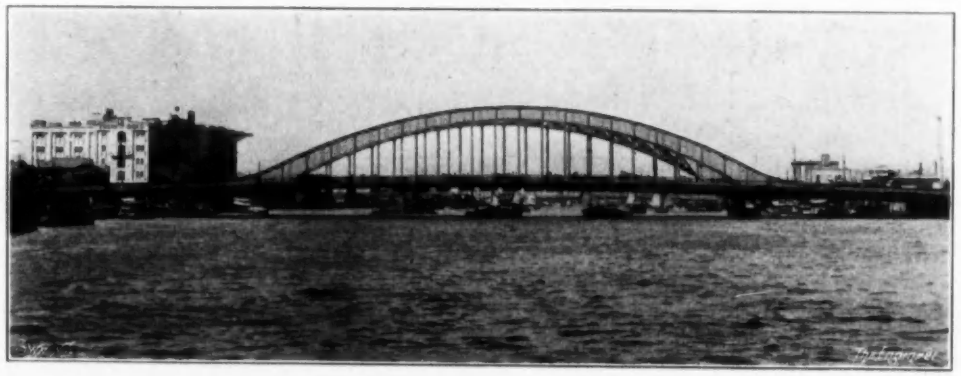
On March 24th his Majesty the Emperor, who was Prince Regent in 1923, will view his reconstructed capital from several eminences which will afford almost a birdseye view of the beginnings of the new city—for as yet it is still in skeleton form.

PRE-EARTHQUAKE RECONSTRUCTION PLANS.

During his mayoralty, 1921–22, the most vigorous public man of his day, the late Count Goto, developed plans for the reconstruction and also the extension of the capital. He initiated the "Greater Tokio" scheme, which would take in vast suburban areas, and give the city a population of five millions. It was Mayor Goto who invited to Tokio an American city planner, Dr. Charles Beard, who made a thorough survey of the city and presented a report, which was, as it were, fertilised and made possible of execution by the disaster of the succeeding year, when Dr. Beard came again, realising that turbulent Nature had presented the greatest opportunity that a city every enjoyed to re-create itself.

But the reconstruction idea long ante-dated these

POST-EARTHQUAKE BRIDGES IN TOKIO



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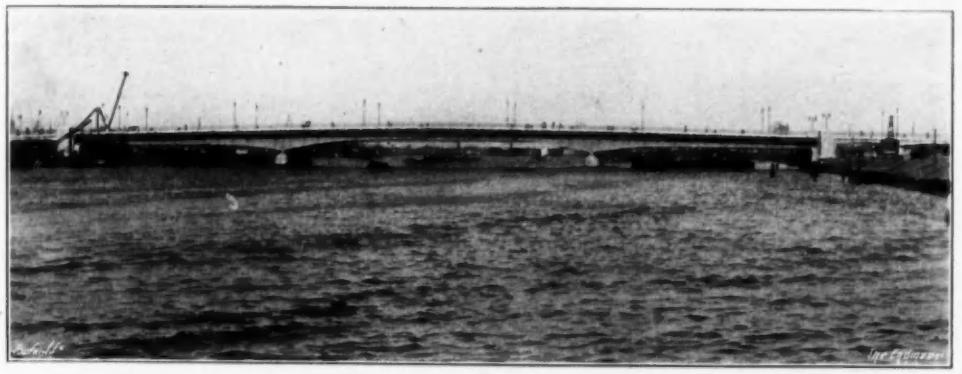

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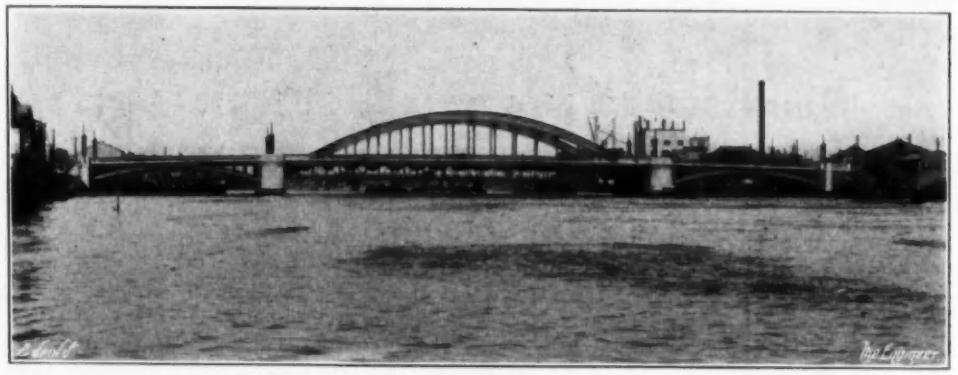

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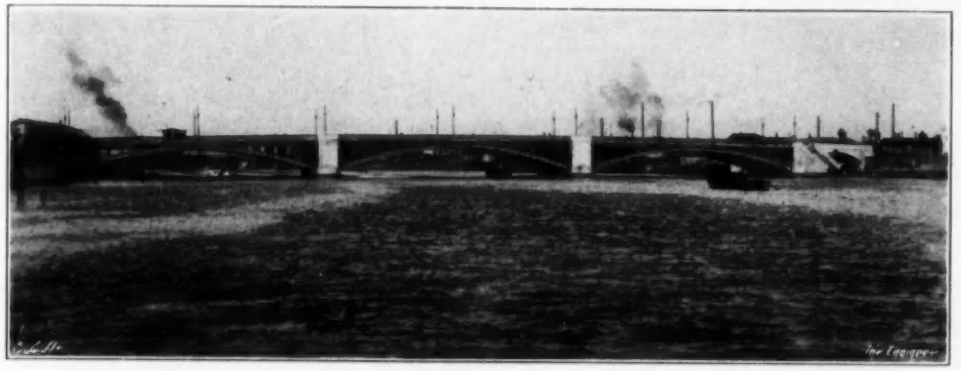

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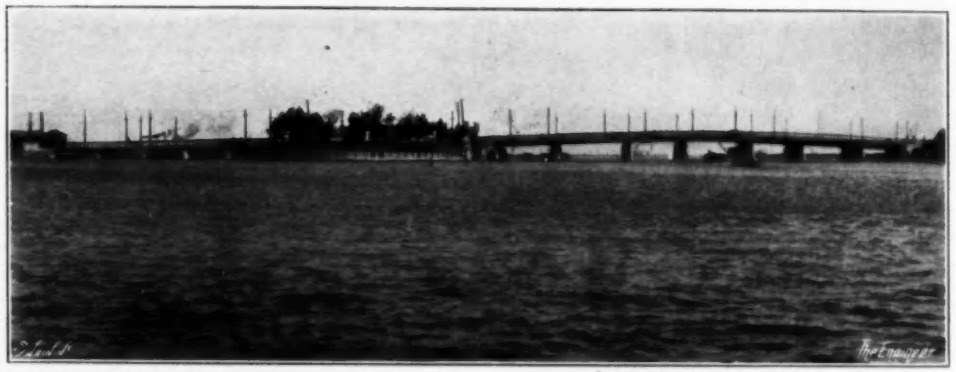


AOI

KIYOSU

efforts. Probably the first shock to the official conscience in regard to sanitary matters came during the visit of the bacteriologist, Koch, to Tokio in 1906. At that distant time the open drain was more in evidence than it is now. Very soon afterwards the plan for a complete sewerage system took shape, but construction was not actually begun until 1911, work being started in the crowded northern wards of Asakusa and Shitaya. Five years later work was started across the river in low-lying sections of the city subject to yearly floods; and in 1920 work in the central areas was begun. Then came the disaster of 1923, and much of the work had to be done all over again.

Closely allied with reconstruction plans was the formation of the Municipal Research Institute, initiated by Goto, and made possible by the gift to the city of a million yen by a public-spirited citizen. This institution has a staff devoted to the study of city planning and municipal affairs the world over, and is, presumably, rendering valuable service.

Other pre-earthquake measures revealing recognition of the need for reform were the enactment in 1919 of a city-planning law, and in the succeeding year of building regulations, with a view to the protection of the city against its most dreaded enemy, fire.

Viscount Goto—as he was then—was Home Minister in 1923, and was immediately appointed head of the Imperial Commission that was to direct the work of rebuilding. He was eminently the man for the task, but even during that trying time political rivalry was in the ascendant, and one who had done so much for the city was compelled to retire and see others do indifferently what he could have done so well. Later, the powers of the Commission were severely curtailed. The original and hastily determined scheme embraced the reconstruction of the whole of the city—an enormous task, quite beyond the national financial capacity, the estimate of cost being Yen 3,500,000,000 (350 millions sterling). After much reconsideration and amendment, the plan was reduced to the provision of essentials—laying foundations upon which the city would develop under normal conditions. The work of reconstruction was thus confined to the widening of streets, the main arteries of the city, involving great purchases and exchanges of land, paving the streets and providing proper foot walks, reserving areas for parks and open spaces, the building of bridges, the completion of the sewer system, building conduits, the provision of schools, hospitals, and markets, and the restoration of the waterworks and lighting systems.

Work Accomplished.

What has been done during the past seven years by the State, the Prefecture (Fu), and the City (Shi), may be set forth briefly as follows :—

By the State—

Reconstruction of roads and streets, of a total length of 170 kiloms., including ninety-six bridges, the widths being from 22 m. to 73 m.

Reconstruction of canals, of a total length of 14,701 m., including fifteen bridges.

Creation of new parks in crowded city areas, of a total area of 229,000 square metres.

Readjustment of street frontages to the extent of 300,000 square metres.

Appropriation of Yen 30,000,000 to carry out the provisions of the Anti-fire Building Subsidy Law, enacted in January, 1927.

By the Prefecture—

Construction of suburban circular avenue and ten radial roads; construction of the Tokio–Yokohama highway; and highways leading out to northern and north-eastern provinces.

Construction of bridges beyond city limits.

Restoration of educational institutions, including middle, high, and industrial schools, within city.

By the City—

Readjustment of land. The burned area, 8783 acres (11,000,000 tsubo), was divided into sixty-five sections, and the City undertook the readjustment of fifty of these, with a view to street widening, &c.

Reconstruction of 122 streets, from 8 m. to 22 m. in width, involving reconstruction or repair of 134 bridges.

Street paving and new bridges: Area of paved street, 1,115,473 square metres; border stone, 3790 square metres; bridges repaired and reconstructed, 154 and 84 respectively; additional bridges built, 53.

Parks and open spaces: 51 small parks, equipped with trees, flower beds, and playgrounds.

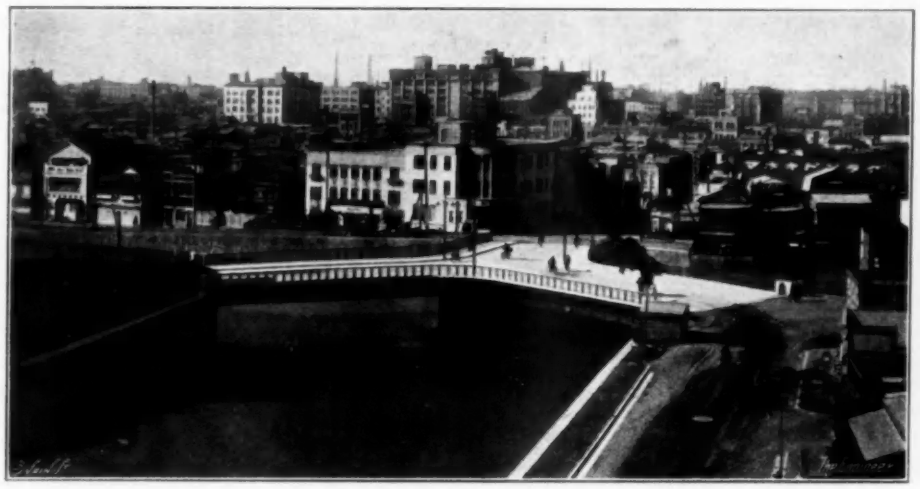
Garbage destructors, wholesale and retail markets.

Elementary schools: Reconstruction of 116 destroyed by fire; all three-storied ferro-concrete buildings.

Hospitals: Five two-storied ferro-concrete buildings, with dispensaries supplying medicines at cost.

Waterworks: Restoration of the old and provision of new waterworks.

Electric equipment: Restoration and extension of the municipal tramways, electric wiring, transformer stations, &c.



MIYOSHI BRIDGE AT A CANAL JUNCTION

Social welfare equipment: Establishment of twelve labour exchanges, ten crèches, four women's industrial institutes, ten public eating-houses, ten cheap lodging-houses, seven municipal pawnshops, ten public bath-houses.

Such is the record in its briefest form, and without reference whatever to private enterprise or to the work of the Railway Department—a department of State—which has carried out, and is still carrying on, an enormous programme of rebuilding and extension.

A member of the recent Engineering Congress prepared figures showing the comparative position of Tokio in respect of the street area compared to the area of the city as a whole. Following is the result of his calculations :—

	Of city area. Per cent.
Pre-earthquake Tokio	11·6
To-day	27
London	23
Paris	25
Berlin	26
Vienna	35
New York	35
Washington	54

A table is appended showing the costs incurred respectively by the State, the Prefecture, and the City for the foundation work accomplished, from which it will be seen that over 70 millions sterling have been expended during the past seven years.

	Yen.
By the Prefecture—	
Repairs to prefectural roads	11,254,036
Construction of suburban circular roads	7,500,000
Repairs to schools and school equipment	3,250,000
By the State—	
Construction of main city streets	257,458,400
Repair of city waterways	28,879,065
New parks, large	11,900,000
Readjustment of streets	8,750,000
Subsidy towards construction of fireproof buildings	30,000,000
Total Expenditure—	
By the City	336,987,465
„ Prefecture	22,004,036
„ State	350,402,828
Grand total	709,394,329

The Bureau of Reconstruction.

With the completion of its work, the Bureau of Reconstruction, which is a section of the Home Office, will be dissolved. Mention should be made of the heads of the Bureau, which has achieved such a remarkable transformation in seven short years, an achievement probably without parallel in the history of cities. The Director of the Bureau is Mr. N. Nakagawa; Chief of the Public Works Section, Mr. D. Oka; Chief of Architectural Section, Mr. T. Kasahara; and Chief of Finance, Mr. T. Yoshimura.

The City Bridges.

Accompanying this article are photographs of a few of the hundreds of bridges which in the past seven years have been repaired, reconstructed, or newly built. These are of a variety and style quite in keeping with the extraordinary ideas worked into the elevations of other city buildings, large and small. As one Japanese engineer said in a paper read before the Engineers' Congress, Japan may be "finding" herself architecturally, and gradually developing a distinctive national style. The fact implies an admission. Architecture, as an art, is making a beginning in Japan. For generations the builders builded the beautiful Buddhist temple, their houses, and places of business, each in one uniform style, the temple architecture having been evolved in other Buddhist lands. Through hundreds of years no demand whatever was made upon the imagination; and the same applies to dress, to paintings, and every article of utility and adornment. All unconsciously, the beautiful work was done, by a people whose taste was moulded into rigid forms.

The coming of the West has spelled disaster to Japan in a spiritual and artistic sense. The gradual development of self-consciousness has not been happy in its fruits. The bizarre in art and life has an irresistible attraction for the Japanese mind, the new mind, that is creating—something that would not have been permitted by bureaucratic rulers in a day not so distant!—and what will be the outcome in future years will not fail to interest the people of other countries.

River and Canal Bridges.

Bridge building, like other reconstruction activities, was apportioned among the three authorities—State, Prefecture, and City. The Reconstruction Bureau was responsible for six bridges crossing the Sumida within city limits, the City for three, while the Prefectural Government built one large bridge just beyond the city limits. Below is a list of the Sumida bridges—see page 296—and some of the smaller bridges—see page 300—built by the Reconstruction Bureau :

Name.	Type.	Cost in yen.	Dimensions.
1. Eitai-bashi	Arch	2,000,000	33 met. 184 m.
2. Kototoi-bashi	Girder	2,400,000	22 238
3. Komagata-bashi	Arch	1,800,000	
4. Kuramae-bashi	Arch-deck	1,800,000	22 173
5. Aoi-bashi		1,500,000	192
6. Kiyosu-bashi	Suspension	3,100,000	22 186

As will be seen in the engraving, Aoi-bashi, which is at the mouth of the Sumida, is broken in the centre by a piece of land which has been converted into a pleasure garden. Among the hundreds of bridges crossing canals, &c., the following may be listed :—

7. Edo-bashi, near Stock Exchange.—Yen 800,000.
8. Hijiri-bashi, near Russian Cathedral.—Yen 800,000. (Hijiri = Saint; the bridge probably so-called because of its proximity to the church).
9. Tokiwa-bashi.—Yen 300,000.
10. Aiyame-bashi.—Yen 250,000.
11. Miyoshi-bashi, at a canal junction.—Yen 200,000.
12. Toyomi-bashi, truss girder without diagonal.—Yen 300,000.
13. Kabuto-bashi.—Yen 200,000.

Expenditure in Yen by State, City, and Prefecture on Reconstruction Work (000's *omitted*).

By the City.	Total sum allotted.	Expenditure in Thousands 1923.	1924.	1925.	1926.	1927.	1928.	1929.	1930.
Road construction: Land readjustment	176,052,994	2,139	19,565	23,289	24,452	37,464	53,104	16,045	—
General reconstruction	133,919,834	3,050	29,150	28,825	23,500	15,364	15,655	15,988	2,391
Roads and bridges	12,453,221	600	3,500	3,000	3,000	765	818	770	—
Sewers	42,211,321	1,500	8,400	8,400	8,400	3,761	8,400	1,350	—
Parks, small	14,341,196	950	1,900	1,900	1,900	1,840	2,675	3,175	—
Primary schools	40,939,096	—	8,000	8,000	8,000	8,000	1,610	7,329	—
Hospitals	3,100,000	—	1,350	750	500	50	200	250	—
Rehabilitation of areas devastated	26,427,048	—	2,949	3,623	4,782	5,395	3,835	4,866	972

14. Sukiya-bashi, reinforced concrete.—Yen 300,000. Building in background office of Asahi newspaper.
15. Nanmon-bashi.—Yen 200,000.

A Record in Steel Frame Building Construction.—The largest office building in London is at present under construction on Grosvenor-road for Anglo-Properties, Ltd., and it is anticipated that it will be ready for occupation by October, 1931, for work is proceeding at a rate altogether without precedent in the building trade. The steel frame, which will weigh nearly 12,000 tons when complete, is being erected at an average rate of over 400 tons per week by means of eight cranes concentrated on the site, and during the week ending March 1st no less than 1080 tons of steel were fixed, constituting a record for the country and easily beating the previous record of 680 tons in one week at Empire Hall, Olympia, which was also erected by Dorman, Long and Co., Ltd. British steel is used throughout on this contract, the requirements all being met from the company's mills at Middlesbrough.

Hydraulic Couplings for Internal Combustion Locomotives.

WHEN describing in our last issue the 300 B.H.P. oil engine-driven locomotive which has recently been built by Hudswell, Clarke and Co., Ltd., of Leeds, for the service of the Compania de Salitres y Ferrocarril de Junin, of Chili, we made reference to the patented ring valve type of Vulcan-Sinclair coupling which is fitted between the engine and the gear-box. By the courtesy of the Hydraulic Coupling and Engineering Company, Ltd., of Ceylon Works, Worton-road, Isleworth, Middlesex, we are now able to give some further details of this useful power transmitting device, which has been specially designed for locomotives driven by internal combustion engines and similar drives.

The coupling is, as our illustrations Figs. 1 and 2 indicate, a transmission gear of the pump turbine type, which consists essentially of an impeller driven by the engine and a runner attached to the driven shaft. From Fig. 1 it will be seen that the runner is enclosed within a casing which rotates along with the impeller. The whole of the coupling is filled with thin lubricating oil, which acts as the power-transmitting medium. The power actually transmitted by the coupling is varied by regulating the internal circulation of the oil by means of a ring valve operated from the driver's cab.

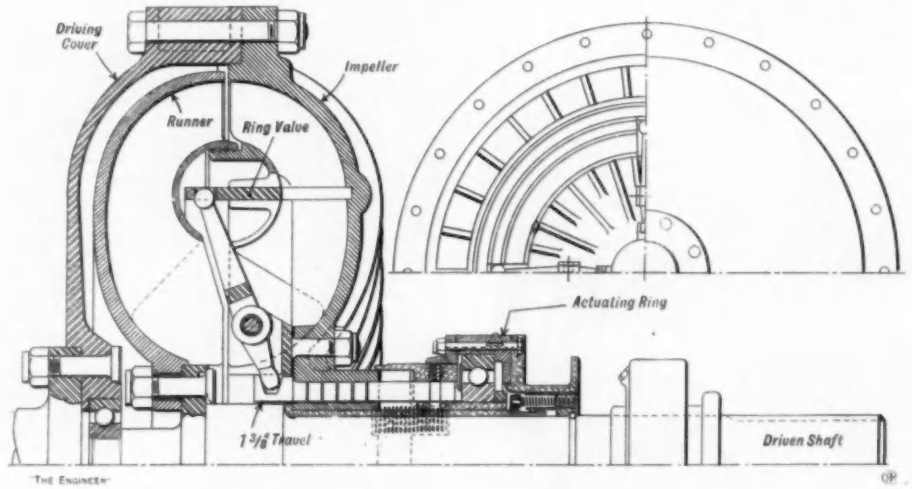


FIG. 1—HALF-SECTION THROUGH COUPLING

It may be recalled that within recent years hydraulic couplings of a similar type, but without the ring valve specially designed for locomotive work, have been extensively and successfully employed for marine work. Such couplings have been largely used for exhaust turbines working with reciprocating engines on the Bauer-Wach principle and complete units up to outputs of 6500 S.H.P. have been constructed. The marine type of hydraulic couplings in service and under construction now amount to a total output of more than 200,000 S.H.P.

CONSTRUCTION OF THE COUPLING.

The particular feature of the new coupling we are describing is the ring valve, which is clearly shown in Fig. 1. From the drawing we reproduce it will be seen that the driving cover, which is made in cast steel, is mounted directly on the engine crank shaft. The impeller is cast in a high tensile aluminium alloy, and it is in turn bolted to the driving cover. As these two units rotate with the crank shaft the necessary fly-wheel effect desired is obtained. Like the impeller, the runner, which is mounted on the driven shaft, is made of high-tensile aluminium alloy. The ring valve is carried within the impeller, and in Fig. 1 it is shown in the full open position, which corresponds to the full driving engagement of the coupling. The valve is moved by four push and pull rods extending from an actuating ring outside the coupling, pivoted levers magnifying a rod movement of about 1⅜ travel to give a 3in. travel at the ring valve. In the extreme right position the valve is closed. As previously mentioned, the internal spaces of the coupling are entirely filled with a lubricating oil of low viscosity, and escape of oil is prevented by a simple spring-loaded gland at the point at which the runner shaft passes through the boss of the impeller. As shown by Fig. 2, the impeller and the runner are generally similar in their construction, each being furnished with passages for the circulation of the liquid. These passages correspond to the ports of the impeller of a centrifugal pump and those of the runner of a Francis type turbine, except that the vanes are straight radial blades.

THE METHOD OF OPERATION.

When the impeller is rotating the liquid in the vaned passages is swirled round with it and by centrifugal force is thrown radially outwards in a continuous stream, as in a centrifugal pump. It is discharged into the corresponding passages of the runner, which are opposite to the impeller, and by impinging against the vanes of the runner causes it to rotate. The continuous discharge from the impeller forces the liquid within the vaned passages of the runner in a direction radially inwards towards the centre, whence it returns to the inlet ports of the impeller and so repeats the cycle. Thus, in addition to the rotational motion of the liquid, there is set up a continuous circulation of fluid in a direction radially outwards through the impeller ports and radially inwards towards the centre through the runner ports. This circulation is virtually the means whereby the transmission of power is effected by the continuous impact of liquid against the runner vanes.

The runner is set axially clear of the impeller by about ⅛in. to ¼in., and there are no fine internal clearances. Furthermore, no wear is caused by the circulation of the liquid. The driving pressure against the vanes of the runner, owing to their large working area, only amounts to a few pounds per square inch. At full engine speed the slip between the impeller and the runner, which is necessary to effect circulation, is only of the order of 2 per cent. The object of the ring valve already referred to is to provide a means for increasing the slip, or conversely of reducing the driving power by decreasing the discharge of the liquid from the impeller into the runner. When the ring valve is in its closed position no circulation of liquid can take place through the impeller passage, and the torque then transmitted to the runner is only that derived from eddies and skin friction.

At all times the transmission efficiency is the direct reciprocal of the slip and at full speed it is, we are informed, of the order of 98 per cent. When working under conditions of high slip such as at starting, the ring valve is closed and the slip is at its maximum, with a corresponding low power transmission efficiency for the very short period involved. The energy which is lost appears as heat in the oil, but such heat is quickly dissipated by the rotating casing, and no overheating occurs. The coupling can be worked at reasonably high temperatures with no harmful effects. At full speed the heating is quite negligible.

An interesting feature of the coupling is the non-stalling character of the drive. The torque which can be transmitted is directly dependent upon the engine speed, so that when an overload is applied which causes the engine to lose speed the slip begins to increase very slowly at first and then at a rapidly increasing rate, so that eventually the runner shaft stalls while the engine continues to run at a fraction of its full speed. This feature is illustrated in Fig. 3, which shows the slip plotted against engine speed at full load torque with the coupling in full engagement. Although under such conditions the slip may be 100 per cent., the torque developed by the engine is transmitted in full to the driving wheels. Correspondingly, at this low engine speed the power dissipated as heat is only about one-fifth of the full-speed power. The torque transmitted and the speed at which the engine will run with the coupling "stalled" depends upon the engine, but it is claimed that no harm can come to the coupling even if it be run over extended periods, always providing the limits of excessive heating are not overstepped. As soon as the overload is removed the engine immediately resumes its speed and the slip is decreased to normal. The action we have described is self-regulating and is inherent in the design of the coupling. By manipulating the ring valve the engine can be assisted to overcome the overload. This is done by speeding up the engine momentarily and then re-engaging the coupling quickly to take advantage of the fly-wheel energy of the rotating parts. Such re-engagement can be effected with entire absence of shock.

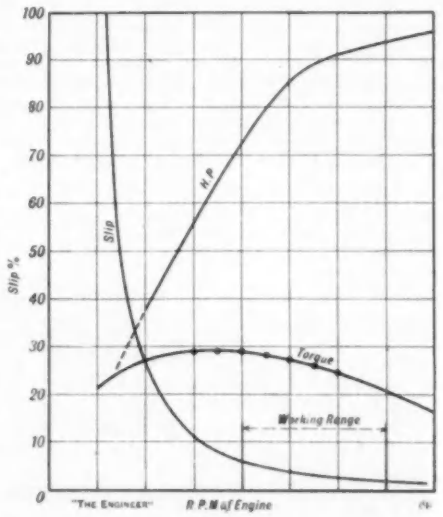


FIG. 3—POWER, TORQUE AND SLIP DIAGRAM

A further most valuable characteristic which is claimed for the coupling is that it cannot transmit torsional vibrations between the crank shaft and the gear-box. Many cases occur in which an engine may be called upon to work through periods of crank shaft vibration when hauling a train. As the functions of the liquid coupling is to equalise the impulses of the engine, the load transmitted to the gearing is made practically equivalent to that of a slow-speed turbine drive, with a corresponding increase in the life of the gearing. In the coupling we examined on the Chilean locomotive the drive was noticeably silent. The coupling we have described is one which should prove very useful, not alone on oil engine-driven locomotives, but also for similar drives on excavators, dredging cutters, and paddle-wheel vessels.

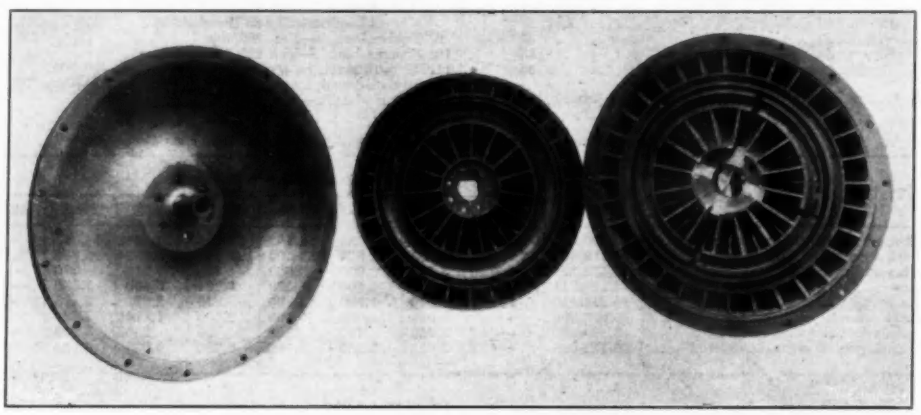


FIG. 2—DRIVING COVER, RUNNER AND IMPELLER

SHORT ANNEALING FOR MALLEABLE IRON.

TREATMENT of malleable iron castings by a short-cycle annealing process in electre furnaces which requires only about thirty hours has been carried out successfully by the General Electric Company of America after investigation of the annealing action. Absorption of free cementite was found to depend upon both time and temperature, and the same applied to precipitation of carbon, the tests developing the effects of various temperatures for different periods. After trials with an experimental furnace of 130 kW and having a capacity for 2000 lb. of castings, three 325-kW furnaces have been built each of 6 tons capacity. Together they produce about 100 tons per week with an annealing cycle averaging twenty-eight hours. In the furnace the castings are first heated to 1832 deg. Fah. rather rapidly—or in about six hours—and this temperature is maintained for four hours, being then reduced gradually to 1364 deg. in four hours and again held for four hours at this lower temperature. It is again dropped a step to 1346 deg., held for four hours; dropped to 1318 deg. and held for a final four-hour period. The castings are then removed and allowed to cool either in open air or in a cooling chamber. The castings are stacked in cars having bodies of refractory brick, which are raised into the overhead furnaces. Physical properties on such annealed castings are said to be very favourable, the tensile strength being about 56,000 lb. and the elongation being 15 per cent. in 2in. They have very little skin and can be machined more easily than castings annealed in the usual way, while warping is much less. Galvanising does not cause brittleness, and no preliminary heat treatment is needed. Besides this, boxes and packing material are not required and there are the advantages accruing from the great saving in time in producing finished castings.

THE Norton Grinding Wheel Company, of Worcester, Mass., has decided to establish a British manufacturing plant at Welwyn Garden City. A site of over 11 acres has been taken, and work on the factory will, it is understood, start probably in April or May. The site has road and rail frontages and will have separate private sidings for inwards and outwards traffic, and a special main loop siding. A British company was registered at Somerset House last February, under the style of the Norton Grinding Wheel Company, Ltd., with a capital of £200,000.

Railway and Road Matters.

FOR the colour light signalling between Paddington and Southall on the Great Western Railway, mentioned in this column on February 7th, 400 light signals will be required and 90 facing point and bolt electrical detectors.

THE thirty "Garratt" locomotives, recently ordered by the London, Midland and Scottish Company, will, in addition to saving one set of enginemen per train, displace sixty-eight freight tender engines that are due for renewal.

THE death is announced of Dr. A. T. Hadley, who was, in turn, a graduate, instructor, professor and, eventually, President of Yale University. The last-named office he held from 1899 to 1921. He was a great economist and, of railway economics, the greatest.

THE chairman of the Southern Railway announced at the annual meeting on February 27th that new engine construction was being carried on at Eastleigh and Ashford only; engine repairs are to be done at those two places, while Brighton is to be used for light repairs only. Repairs to all bogie stock will be made at Lancing, where such repairs will be carried out on a modern and progressive system. New wagon construction and general repairs to wagons are to be centralised at Ashford.

THE report for 1929 of the Great Southern Railways of Ireland shows that though the receipts from railway working, when compared with 1928, fell by £144,000, the expenditure dropped by £200,000, and so the net receipts were £818,997, as against £764,552. A rise of from £9054 to £17,936 in the net receipts from hotels, refreshment rooms, and cars just about compensated for the loss from other businesses, and so the company paid 1 per cent. as before, and carried forward £95,805, as compared with a carry forward of £18,392 a year ago.

ANSWERING a question recently, Mr. Morrison, the Minister of Transport, said that the experiments made in the provinces with automatic traffic signals were generally giving satisfactory results, and arrangements were being made to carry out an experiment in Oxford-street. Answering a further question as to manufacture, Mr. Morrison said there was some difficulty as to the capacity of English manufacturers to manufacture according to requirements at the present time, and it might be necessary to experiment with the imported article. As soon as the experimental stage was passed, they would be able to make suitable arrangements with British manufacturers.

IMMEDIATELY north of Culgaith Station, on the Settle and Carlisle section of the former Midland Railway, there are two tunnels—Culgaith tunnel, 660 yards long, and Waste Bank tunnel, 164 yards long. On the morning of Thursday, March 6th, a ballast train was engaged in unloading stone on the down—to Carlisle—line at a point just north of the latter tunnel. The engine was at the southern end of its train, and in the tunnel, and, whilst standing there, was run into, head-on, by a passenger train from Hellifield to Carlisle. The driver of the passenger train was killed. The coroner's inquest was opened on Saturday, March 8th, and adjourned until March 17th. The tunnel was so obstructed by the two engines after the collision that the breakdown cranes could not work on them and they had to be drawn out gradually by tackle.

THE gross receipts from railway working during 1929 on the London and North-Eastern Railway were £55,561,094, as compared with £54,112,863 in 1928, and the expenditure was £43,282,641, as against £43,331,158. The gross receipts from all sources were £63,295,455, as compared with £61,423,959, and the total expenditure was £50,895,513, as against £50,738,129 in 1928, so that the net receipts from all sources were £12,399,942 in 1929, as compared with £10,685,830 in 1928. The number of passengers increased from 199,920,376 to 213,612,948, of which increase 48,000 were in first-class passengers and 600,000 in workmen. The weight of the freight traffic rose from 136,831,498 tons in 1928 to 150,982,763 tons in 1929. Of this increase, 500,000 tons were in general merchandise, 2,000,000 in minerals and merchandise, (classes 1–6), and over 11,000,000 in coal.

THE electrical equipment for two Diesel-electric locomotives for the North-Western Railway, India, has recently been completed by the General Electric Company, of Kingsway, London. This equipment was made throughout at the company's Witton Works and is in accordance with the Oerlikon system. The locomotives, which are designed for the Indian track gauge of 5ft. 6in., each weigh approximately 50 tons in working order and are of the double-bogie type. They are each equipped with a 350 B.H.P. Beardmore high-speed Diesel engine, direct-coupled to a single-bearing generator with overhung exciter. The generator supplies current to four traction motors mounted upon the bogie axles, control being effected by master controllers arranged in the driver's cabs at either end of the locomotive. The locomotives are designed to haul loads up to 100 tons at a maximum speed on the level of approximately 47 m.p.h. and at correspondingly less speeds on gradients up to 1 in 50.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the month of January last was as follows, the corresponding figures for January, 1929, and January, 1928, being added in brackets:—Locomotives, £346,327 (£324,879, £172,385); rails, £253,576 (£274,099, £364,473); carriages, £137,227 (£287,611, £628,864); wagons, £294,279 (£346,408, £259,715); tires and axles, £59,898 (£57,677, £60,783); wheels and axles, £26,123 (£52,883, £100,867); chairs and metal sleepers, £66,583 (£58,534, £93,080); miscellaneous permanent way, £83,222 (£114,511, £74,608); total permanent way, £499,948 (£569,863, £708,982). The weight of the rails exported was 29,343 tons (33,962 tons, 43,650 tons), and of the chairs and metal sleepers 6848 tons (6685 tons, 9785 tons). Among the locomotives shipped in January last there were the following supplies:—India, £129,955; the Argentine, £82,931; South Africa, £45,000; other countries in South America than the Argentine, £6376; Australia, £1100. Included in the rails sent overseas in January there were:—The Argentine, £95,945; South Africa, £39,332; Portuguese East Africa, £33,930; India, £14,357; Straits Settlements, £12,493; New Zealand, £6176.

Notes and Memoranda.

A BRIEF review of the welding developments during the year 1929 prepared by a Committee of the American Welding Society gives considerable information regarding the application of arc welding to structural work. The number of buildings and structures erected by the use of arc welding materially increased during that period. The first statistics of this nature were prepared by Frank P. McKibben in July, 1928, when he listed 100 structures, consisting of bridges and buildings. In July, 1929, the total had increased to 138. The number of welded buildings alone increased from forty-three to sixty-five.

IN the course of the discussion of a lecture on "Spontaneous Combustion in the Warwickshire Thick Coal," read before the South Staffordshire and Warwickshire Institute of Mining Engineers by Mr. C. E. Morgan, Mr. J. I. Graham said: "Increased ventilation over the affected spot was sometimes adopted at the first signs of heating. To his (the speaker's) mind the effectiveness of this method of treatment must depend upon the friability and also chemical nature of the coal. He thought, generally speaking, in South Staffordshire and South Yorkshire, where the coal was readily oxidisable at ordinary temperature, any attempt to deal with an incipient heating in that way would make the trouble worse. In the case of certain Lancashire, Cumberland and North Staffordshire coals the rate of oxidation at low temperatures was very much less, and no doubt in some of that class of coal such method of cooling might be successful, although, to his mind, always risky."

AN instrument described as an electric "ear," which, it is claimed, will not only enable deaf persons to understand the spoken language, but will permit them to catch the inflections of words now denied them by their affliction, was recently demonstrated before the members of the Franklin Institute in Philadelphia by Dr. Robert H. Gault, of the Vibro-Tactile Laboratory and Institute of North-Western University. Dr. Gault explained that the instrument, which is sufficiently small to go into a waistcoat pocket, substitutes the sensitiveness of the finger tips for the sensitiveness of the membranes of the ear. In other words, the fingers pick up from the "Teletactor," as it is termed, the stimulations of varying intensity and transmit them to the brain in the place of the organ of hearing. Small indentations for the fingers and the thumbs are supplied in the box itself, and the deaf are thus, it is said, able to "read" sounds in the same manner that the blind read Braille type.

A NEW use of the mobility of wireless communication is to be made by the Egyptian State Telegraph Department, which has just ordered from the Marconi Company three wireless sets mounted on motor lorries. These stations will be maintained for use when and where required in areas not supplied by the land telegraph and telephone system, so that practically any point in a wide range of country on either side of the Nile can be linked up at short notice with the main Egyptian telegraph system. The motor lorries, also of British manufacture, will be six-wheelers, fitted with caterpillars so as to be equally mobile on hard or soft desert country. Each lorry will carry a medium wave ½ kW telephone transmitter and a small portable short-wave transmitter of 100 watts power. The aerials will be suspended from 70ft. portable masts, and the wavelengths used will be between 600 m. and 2150 m. on the medium wave set, and from 20 m. to 50 m. on the short-wave set. Self-contained power plant will be provided.

A VERY unusual case of carbon-monoxide poisoning is recounted by the United States Bureau of Mines. Some men in a hut on Brunt Island, Ohio River, were gassed. Tests made by the Bureau of Mines safety engineers with a carbon-monoxide detector showed that there was approximately 1 to 2 per cent. of carbon-monoxide in the atmosphere of the building. Investigation as to the source of carbon monoxide disclosed one of the most novel occurrences of the gas that has ever come to the attention of the Bureau of Mines specialists. The entire upper end of the island has been formed by the dumping of cinders from a boiler plant operated for a period of at least twenty years. This bed of cinders and ashes is at least 40ft. in depth in various places. Various sections of this cinder-ash field had been on fire as recently as two or three months previously. Thus, a great area was forming and giving off carbon monoxide. An intake tunnel was being constructed under the cinder-ash field, and the compressed air from the tunnel, under about 7½ lb. pressure, was being forced up through the cracks and interstices like the passage of air through a blacksmith's blower. This air movement increased the production of carbon monoxide, the formation of which was also considerably aided by the melting of a fairly heavy snow followed by rain, resulting in little, or no air movement on the surface.

IN concluding a paper on the formation and growth of crystals, read before the Institution of Chemical Engineers, Professor W. E. Gibbs said: "The subject of the formation and growth of crystals possesses great interest and importance for industries so widely diverse as those devoted to the manufacture of metals and ceramics, and of chemicals, both heavy and fine. In many cases, the design and operation of actual crystallisation plant reveals a very slight acquaintance with the inner mechanism of the crystallisation process. The operation of many old batch crystallisers is uncontrolled, except by the weather, an uneven and unattractive product is obtained, and heavy labour charges are frequently incurred in breaking up the resulting conglomerate. It is clear that crystallisation can be controlled chemically by adding to, or removing from, the solution various significant impurities. It can be controlled physically by adjusting the number of seed crystals and the rate of supersaturation. It can be controlled mechanically by providing for the efficient circulation and cooling of the solution. It is frequently necessary to control the humidity of the air above the solution, to prevent excessive dilution of the surface layer of the solution. A subsidiary problem of considerable importance is effective utilisation of the heat removed from the hot solution by the cooling medium. Where possible, this heat loss can be minimised by the use of a regenerative system of cooling."

Miscellanea.

IT is proposed to put up a large match factory on the Tyneside.

A DIRECT telephone line has been organised between Berlin and Leningrad.

THE new Krivoi Rog power station in South Russia, with an output of 44,000 kW, is said to have cost £1,650,000.

A SUPPLY of natural gas containing 8 per cent. of helium, the largest proportion so far known, has been discovered in south-east Colorado.

THE Russian Government proposes to construct 1000 factories in various parts of the country for the repair and overhaul of agricultural tractors.

THE Ford Motor Company has adopted a rustless steel containing 18 per cent. of chromium and 8 per cent. of nickel for the exposed parts of its motor cars.

TESTS carried out by the Aluminium Company of America have showed that, weight for weight, aluminium girders will carry 130 per cent. more weight than will steel.

IT is reported that the attendance of buyers at the Birmingham section of the British Industries Fair was, this year, 150,000 persons, as compared with 120,000 last year.

THE Council of the Institution of Water Engineers has awarded the Whitaker Medal to Mr. R. S. C. Walters for his recent paper on "The Hydrogeology of the Chalk of England."

THE British Cycle and Motor Cycle Manufacturers' and Traders' Union, Ltd., announces that this year's International Cycle and Motor Cycle Show will be held at Olympia from November 10th to November 15th, inclusive.

THE Georgia Manganese and Iron Company, Atlanta, Ga., has completed its new manganese concentrating plant at White, Ga., and is starting the production of manganese ore. The annual capacity of the plant is rated at 140,000 tons of ore, running 40 to 50 per cent. metallic manganese.

A COURSE of three "Thomas Grey Lectures" on "Aids to Navigation," is to be given on Monday evenings, March 24th and 31st and April 7th, by Commander F. G. Cooper, R.D., R.N.R., at the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. The chair will be taken at 8 p.m. on each occasion.

A RECOMMENDATION that a special Engineering Commission should be appointed by the Dominion Government to study the matter of improving navigation on the St. Lawrence from Montreal to the sea, was contained in the annual address delivered before the Shipping Federation of Canada by the President, Mr. Robert Reford. The object, he urged, should be the deepening and broadening of the channel wherever necessary in order to attract larger tonnage to Montreal.

DESPITE the depression in shipping, contracts have been placed since the beginning of the year with British and continental shipyards for 47 motor vessels, totalling 303,000 tons gross, according to the *Motor Ship*. The majority are tankers, comprising 27 ships of 170,000 tons gross, while five are passenger liners of moderate size. The remainder, totalling 72,000 tons gross, are cargo ships, the relative paucity of orders for such vessels being natural in view of the shipping slump. Of the new ships that have been ordered, 19 are being, or have been, laid down in British yards.

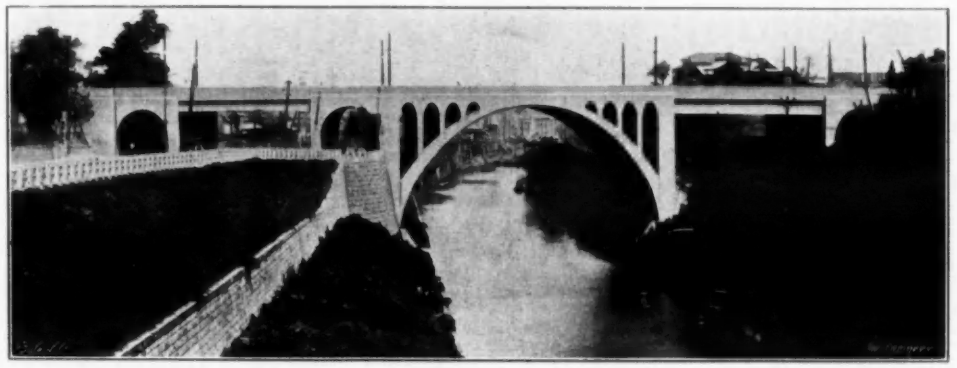
THE Secretary for Mines draws attention to the publication of a new edition of the handbook of "Explanatory Notes" by H.M. Electrical Inspector of Mines on the general regulations governing the installation and use of electricity at mines under the Coal Mines Act, 1911. The handbook is intended to serve as a practical guide to mine managers, electricians, mechanics and others in carrying out their duties under the regulations, in the choice of safe and suitable plant, in its safe installation and efficient maintenance, and generally in the observance of those precautions which experience has shown to be necessary for the prevention of accidents. The handbook can be obtained from H.M. Stationery Office, price 6d.

ACCORDING to the *Electrical Review*, at a recent meeting of the Southend-on-Sea Town Council a report of the Chief Inspector of Factories was read on the condition of the Corporation's generating plant. One engine, it was stated, had run 6500 hours without overhaul, and that unless a complete overhaul was made mechanical dangers and risks of an explosion in the crank chamber were likely to occur. Another engine had a bent crank shaft and knocked in three places. A third engine also knocked in three places. The engine at the Leigh sub-station had already broken two pistons, and was likely to break again. This would involve a general breakdown, with serious consequences. Two engines at the Thorpe Bay sub-station were stated to hold risks of injury to the engineers. The risks entailed, the inspector considered, were unwarranted, and he asked when an overhaul could be started. The Corporation replied that it had been refused permission by the Electricity Commissioners to buy the necessary additional machinery.

A PAPER prepared by Lt.-Col. J. Hartley, M. Inst. C.E., of Chile, and read by Mr. P. C. Dewhurst, M.I. Mech. E., before the Junior Institution of Engineers and in the presence of His Excellency the Chilian Minister and the Chilian Consul on March 7th, gave an exhaustive summary of the geographical and economic features of the country with special reference to engineering activities, past, present and to come. His Excellency, Don Antonio Huneeus, the Chilian Minister, in expressing his pleasure that an English technical engineering institution should display so much interest in the resources of his country, assured the members that the work which British engineers had done in developing the resources of the country was ever present to the mind of the Chilian and that British goods were always very welcome. He hoped that in the big developments now taking place still more opportunities for the employment of British engineering and other products would be found and that British capital would be just as welcome as it had ever been.

POST-EARTHQUAKE BRIDGES IN TOKIO

(*For description see page* 295.)



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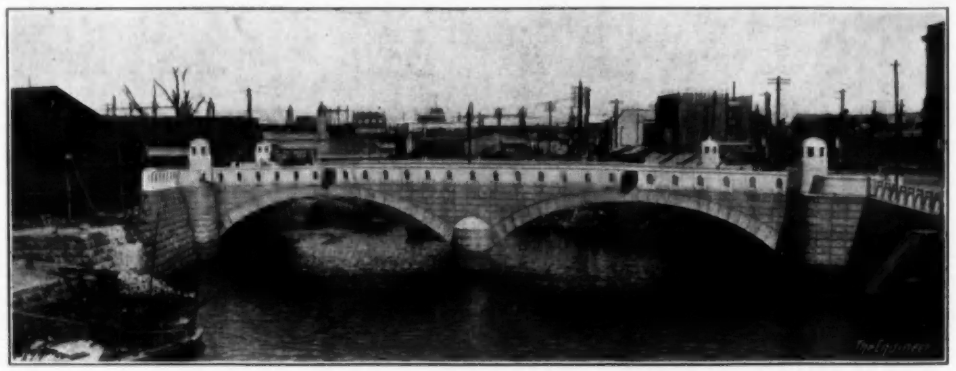

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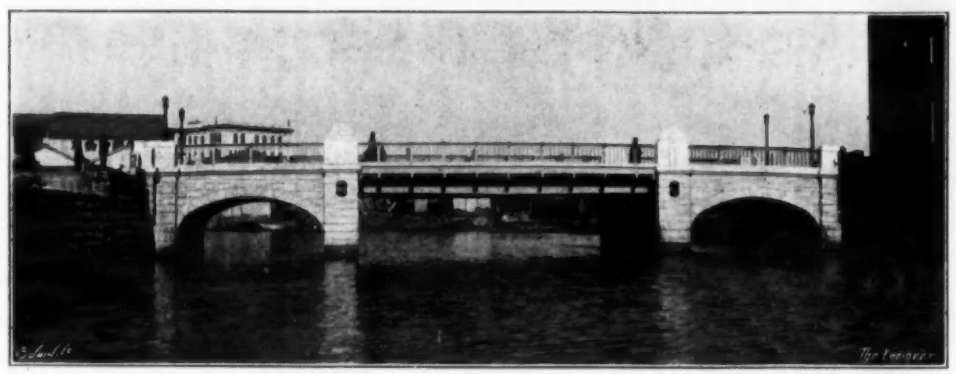

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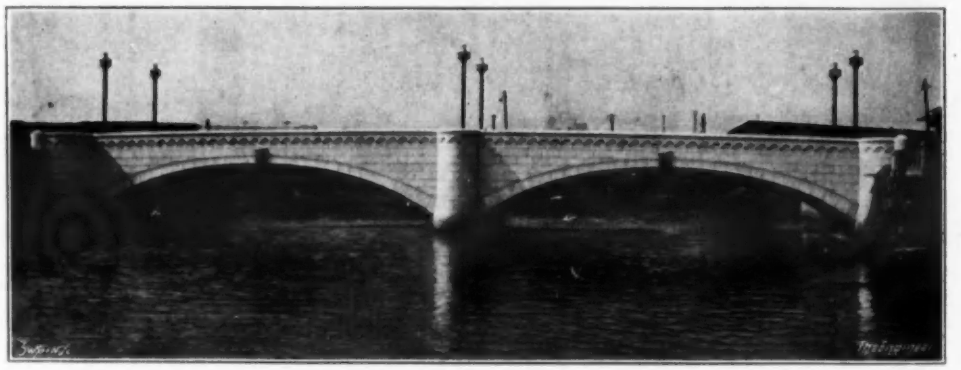

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THE ENGINEER.

VOL. CXLIX No. 3870

MARCH 14, 1930.

The Unemployment Problem.

MORE than a hundred years ago, when machinery was beginning to displace hand labour and factories, driven by steam engines, were springing up on all sides, the artisan regarded the machines with so much distrust and hatred that he destroyed them lest they should deprive him of the means of living. He made a very natural mistake ; his vision was not long enough. The proprietors and economists, who could see further, advanced the doctrine that the machine would increase the demand for labour and improve the conditions. They, as we all know, were perfectly right. For many years the demand for the products of the factories outran their capacity ; they had to be continually enlarged or their numbers augmented and they called for a much greater number of workpeople than could have found occupation in hand labour. At the same time, earnings rose rapidly, owing to the high speed of production of machinery, and the conditions in which the working classes lived greatly improved. The hypothesis that increased output meant decreased cost, further augmentation of demand and, consequently, more and more labour, was justified in every respect. It was so manifestly true that inventors strove continually to increase the rapidity of operation of machinery in the full confidence that a sure market existed for all that could be produced. The workpeople, indeed, protested and effected regulations to prevent the introduction of machinery from reducing the amount of labour ; but, in fact, there was no cause for their anxiety. The more machinery employed and the greater the rapidity with which it could produce, the larger became the demand and the greater the need for labour.

For more than a century there was no sign of weakening in that economic phenomenon. The number of people employed in industry rose steadily and unemployment never became chronic. Slumps occurred, but they were inevitably followed by booms ; there were fluctuations of trade, hard to explain, but never giving rise to prolonged anxiety. Recovery was always anticipated and always came. Students even made out charts to exhibit the periodic incidence of the crests and hollows of employment. That easy certainty of a revival has gone. The whole industrial world, America and Japan as well as Europe, is faced by the problem of finding occupation by which many millions of people may support themselves and their families. There is as yet no approach to a solution, and there never will be until the problem ceases to be a bone of Parliamentary contention and is studied scientifically in all its details. The debate in the House of Commons on Monday last was a familiar exhibition of political ineptitude and party feeling. In the whole of it we can only find one saying that showed anything like a true appreciation of the facts. "From 1920 to 1929," said Mr. Thomas, "no less than 190 million pounds was spent in roads and bridges and other relief works, yet no one can suggest that it gave any permanent contribution to the unemployed problem." That statement does, at least, show a recognition of the fact that the evil is not to be cured by palliatives. Relief work may be a deplorable necessity, an unpalatable alternative to supporting men and women in idleness, but work provided for work's sake can never take the place of work done to satisfy a real and genuine demand. It is there that the root of the problem is to be found. There are those who assert that there is no such thing as over-production ; that no more is needed than good salesmanship to get rid of more than all that can be manufactured. We have got nothing whatever to say against improved salesmanship ; we believe it to be absolutely necessary, but when we see two of the industrial nations of the world which are held up to us as shining exponents of that art, when we see both Germany and America suffering from unemployment as we are suffering, we cannot help asking if, indeed, the salesmanship of the gods themselves could dispose of all that the world would be capable of producing if every working man and woman were usefully employed ? Many other panacea have been advanced, but not one of them goes to the bottom fact, that the capacity of the world to produce is now on a level with its capacity to consume. Year by year we have added to the numbers of employable, partly by increase of population and partly by the augmentation in the number of women workers, which has almost doubled in forty years. At the same time, we have improved machines and methods so that the amount of products that can be turned out by each individual is far greater than it was even ten years ago, with the result that now, with all its efforts, the world is unable to make the consumption of products keep pace with what it could manufacture did it use to the utmost all its present resources.

That, we suggest, is the fundamental problem of unemployment. It is not easy to handle. The old principles are so deeply ingrained that we cannot even begin to suspect that circumstances have altered them. We cannot bring ourselves to believe that the acceleration and cheapening of production does not enlarge the market beyond a certain point. We cannot conceive that what was proved to be manifestly true a century ago may not be true to-day. We are so devoted to a doctrine for which we have fought stoutly through a hundred years that we refuse to listen to a hint that it may be unfaithful to us. Yet the facts are before us. America, with the most advanced methods, with heaps of money and a huge protected market, is unable to find employment for at least three million, and probably six million, of her population. It may be said that she is suffering from a temporary set-back. But the fact is that several million of her industrials have been unemployed for years past—long before the Wall-street débâcle. We have to face the very serious probability that the condition is chronic and that, in present circumstances and with industries springing up in nations which were at one time consumers, unemployment is likely to increase rather than diminish. All the talk about different methods of curing the complaint are idle until we go to the source of the trouble. We shall not find out the true cause by examining surface indications. The X-rays of economic research must be applied without any preconceived ideas and particularly without any political prejudices. The question must be examined scientifically, and when the cause has been found it must be treated rationally, however repellant it may be to our established principles and whatever courage an heroic cure may demand.

The International Aspects of Civil Aviation.

As time goes on it becomes more and more evident that the future of civil aviation is not going to be determined solely by technical considerations, such as the development of improved machines

and engines or the provision of enhanced facilities for flying at night or in foggy weather. Apart from questions of technical detail, and exerting at least an equal influence on advancement, is the political aspect of commercial flying. As engineers we may take a greater interest in the ways and means of artificial flight than in the factors affecting its exploitation for financial or other gain. The two aspects, the technical and the political, cannot, however, be permanently divorced. If we would appraise at its true significance the great progress recently made by the designers and constructors of aircraft, we must have some knowledge of the political factors influencing the establishment of civil aviation services. Opportunity for an examination of the international situation as it now exists in the field of commercial flying is afforded by the paper on German commercial air transport which Herr Martin Wronsky, general manager of the German Luft Hansa, read on Wednesday, March 10th, before the Institute of Transport. Herr Wronsky's remarks present a somewhat one-sided and incomplete picture of the situation. They can, however, be readily amplified by a study of the British Air Ministry's annual reports on the progress of civil aviation. When all the main facts and tendencies are investigated it will be found that the political side of the subject is as full of problems awaiting solution as the technical, and that the manner in which those problems are solved is likely to have as great an influence on the future of civil aviation as anything that is within measure of achievement by our aircraft factories.

For the time being we may exclude the United States from our review of the political factors affecting the development of civil aviation. Until the Atlantic is less of a death trap for airmen than it is at present that country, in spite of its immense aerial activity, will have little or no opportunity of playing a part in the evolution of commercial flying services by European countries. In any event the area to be served within the country's own boundaries is so vast that sufficient scope for development will probably continue to be found for some time to come inside its own territories. Great Britain is situated at the opposite extreme. The small size of the country and its highly organised railway system preclude, and will always preclude, the establishment of internal aerial services otherwise than on a minor scale. According to certain economists, it is hopeless to expect any advantage from the establishment of an aerial service if the route to be covered is less than about 300 miles, and only when the distance to be flown exceeds 600 miles do the benefits of aerial travel clearly preponderate over those of other forms of transport. Great Britain is, therefore, and must remain, compelled to look to extra-territorial routes for the profitable development of her civil flying aspirations. The London - Paris - Basle - Zurich route is not sufficient, as has long been recognised. We have now established an aeroplane service to Karachi and are rapidly establishing one to South Africa. In France a loosely organised system of internal flying services is operated by several different companies. The main French civil aviation effort is, and always has been, however, directed towards the establishment of effective aerial communications with the north and west coast of Africa and with Syria, either direct or by way of Prague, Vienna, Budapest, Belgrade, Sofia and Constantinople. From Rome the Italians run what may be regarded as internal services to Sardinia, Sicily and Trieste, as well as to the principal towns of the Peninsula. Italy is, however, in some respects ideally situated from the point of view of international civil aviation, and is showing an increasing interest in the North African, Balkan and Near East routes. The situation in Germany is peculiar. Deprived of her colonies by the Treaty of Versailles, and, therefore, of a powerful incentive to the development of overseas aerial communications, deprived, too, by the same treaty of practically all participation in military aeronautics, she has organised and established the most intensive system of internal aerial services which the world possesses to-day. Her extra-territorial undertakings are disproportionately small. A service is run to London, another to Barcelona, a third to Oslo, and a fourth to Stockholm. In conjunction with the Russians the Germans operate a service which links Berlin with Riga, Leningrad and Moscow. Quite isolated from the home system the Germans run two services across Persia from north to south and from east to west. Of the other European countries, Belgium, Holland and Spain might be mentioned, but enough has been said to indicate the principal facts in the international situation. With the exception of Germany, which is in an entirely artificial position, the countries of Europe are actively pursuing the development of extensive overseas aerial routes. Competition for traffic except on one or two routes, such as that between London and Paris, does not at present seriously exist. Co-operation rather than competition has so far guided the policy of those charged with the duty of establishing the aerial services of European countries. There are, however, factors in sight which suggest that this condition is unstable. International rivalry between the companies undoubtedly exists in spite of the arrangements made for co-ordination. That rivalry has a political significance which is almost completely absent in the case of shipping, the only other comparable form of international transport. Behind each and every one of the aviation companies stands the Government of its respective country with the liberal official subsidies which alone make it possible for the undertakings to exist. Between them the inhabitants of Great Britain, France, Germany and Italy are paying through their Governments subsidies to the aviation companies at the rate of 2¾ million pounds a year, and in addition are being taxed to provide roughly as much again for assistance otherwise than by subsidy. The competition, actual or latent, on the air routes is therefore not the competition of company against company, but very largely that of nation against nation. The main routes for civil flying services can now be fairly well discerned. With the exception of that between Spain or the west coast of Africa and South America—a route to the development of which both the French and the Germans are giving close attention—it is evident that the general tendency of the services is eastward. It is impossible that the restricted field available for development on the eastward routes can afford full scope for the overseas aviation aspirations of all European countries. Germany, having saturated her internal opportunities, is clearly ready and anxious to enter the international field. These various factors seem to point unmistakably to the near approach of a period of international competition and rivalry on the air routes.

In his paper before the Institute of Transport Herr Wronsky suggested the rationalisation of the European air services and the political combination of all the countries for the purpose of aerial transport. By such means the competition which is now barely held in check might be permanently avoided, but it is doubtful if the establishment of a universal aviation undertaking is practicable in the present state of European politics. Not until civil flying becomes independent of Government subsidies—a condition unlikely to arise in the foreseeable future—will the aspect of national rivalry behind it become sufficiently modified to permit such a scheme to be seriously considered. So long as the different Governments find it desirable and necessary for their own ends to encourage civil aviation by the granting of heavy subsidies, for so long will they be proportionately anxious to maintain the subsidised services under the sole control of their own nationals. It should not be forgotten that the fundamental object of the subsidies is a military one. They are not granted primarily because of the commercial advantages which civil aviation services bring to the countries establishing them. Their principal motive is to cultivate a demand from the civil side for the products of factories making military machines, to provide a reserve of civilian pilots on which the Government could draw in times of national emergency and to create fleets of passenger or goods-carrying aircraft which would have a certain value in war. These objects would be largely lost if the European air services were placed in the control of a single international company. It is scarcely open to doubt that such a move would lead to the immediate withdrawal of all Government subsidies. To forecast the political future of civil aviation is extremely difficult. Are we to witness within the framework of the existing schemes of subsidisation an intense and ruinous competition, nominally between one company and another, but in effect between nation and nation? Or are we to see a continuation of the present policy of co-operation until such time as the companies become self-supporting? When that time arrives will the companies decide on amalgamation or competition or will the choice be denied them by the dictation of some particularly powerful or favourably placed company or group? Having, in common with other nations, set ourselves the task of establishing civil aviation services and having, also in common with other nations, been compelled to resort to the policy of subsidisation, we cannot now turn back. We have raised for ourselves by so doing problems difficult of solution, costly and in some respects dangerous. It will require statesmanship and something of the Locarno spirit to solve them.

The Institute of Metals.

No. I.

ONE of the outstanding features of the twenty-second annual general meeting of the Institute of Metals, which was held in London on Wednesday and Thursday of this week, was the constant reference made to the increasing value of international co-operation between scientific bodies of this kind, and to the arrangements which are being made continually for closer collaboration in the matter of research. Certainly the beneficial results of the Institute's joint meeting with kindred bodies in Düsseldorf last autumn are becoming increasingly evident.

The meeting took place in the lecture hall of the Institution of Mechanical Engineers on Wednesday morning. Dr. Walter Rosenhain, F.R.S., the retiring President, presided during the earlier part of the proceedings, and later inducted his successor, Dr. R. Seligman, into the chair.

THE ANNUAL REPORT.

The retiring President moved and Mr. W. A. C. Newman seconded the adoption of the annual report of the Council for the year ended December 31st, 1929.

REPORT OF COUNCIL.

In this report the Council states that the year had been notable for some incidents of special interest in the history of the Institute. The twenty-first annual general meeting was marked by a "coming-of-age" celebration, which saw the Institute's membership pass the 2000 mark.

The autumn meeting at Düsseldorf was marked by one of the largest attendances of members and ladies—310 in all, including representatives of eighteen nationalities—which has yet been recorded at any autumn meeting, a fact which confirms the opinion of the Council that the holding of such meetings at suitably selected centres abroad is a welcome feature in the arrangements of the Institute.

The successful meeting of the Institute at Düsseldorf, following upon the meeting of the German society, brought forth the suggestion that closer international co-operation was desirable, particularly in regard to metallurgical research. This suggestion was warmly taken up by the French and German members of the Institute present at Düsseldorf, and as a result an effort has been made to bring about a preliminary conference in London for the purpose of discussing the possibility of forming an international metallurgical research organisation which should secure closer co-operation in the future. The Council has placed the facilities of the Institute of Metals at the disposal of this preliminary conference, and it is hoped that successful results will be achieved.

Another important development during the past year was the decision of the Council to participate in the movement for the erection of a joint building for the purpose of housing a number of scientific and technical societies which at present are scattered in offices in various buildings in different parts of London. The scheme for a joint building originated with the idea that the principal metallurgical societies, including the Institution of Mining and Metallurgy, the Iron and Steel Institute, and the Institute of Metals, should be accommodated in a single building. The scheme has, however, been extended to include a considerable number of other societies and institutions, including an important group of chemical societies. The Institute has been actively represented on the various committees formed with a view to exploring the possibilities of such a scheme and, subsequently, of organising an appeal for securing the necessary funds. The scheme has now progressed to a considerable extent; substantial financial contributions have been promised from a number of sources, and it is hoped that the purchase of a site and the erection of a building may proceed in the near future. In deciding that the Institute should participate in this scheme, the Council feels that by co-operation with other technical and scientific bodies in this way the best interests of the Institute will be served. It is anticipated that, not only will such a scheme provide better accommodation for the actual offices of the Institute, as well as the use of a lecture theatre, but also that it will facilitate closer co-operation between the participating societies, with possibly considerable resulting economies, particularly in regard to their publications, while it will also secure the more effective presentation of the views of technical and scientific bodies on all questions of public importance with which they are concerned. While the Institute is now fully committed to participation in the joint building scheme, it should be noted that beyond a small contribution to the preliminary expenses, no financial obligations have been incurred or contemplated beyond the undertaking that when the building is ready the Institute will rent accommodation at least equal to its present rooms at a total cost not greater than is now paid.

The number of members on the roll of the Institute has increased substantially during the year. On December 31st, 1929, the totals for the various classes of membership were as follows:—

Honorary members	5
Fellows	9
Ordinary members	2035
Student members	73
	2122

One additional name was added during the year to the list of honorary members—that of Professor Dr. G. Tammann, the *doyen* of German metallurgists.

Because of the eminence of their service to the Institute, and in commemoration of its coming-of-age, the Council elected as fellows the President, Dr. W. Rosenhain, F.R.S., and the six surviving Past-Presidents, Professor Sir Harold Carpenter, Kt., M.A., Ph.D., A.R.S.M., F.R.S.; Sir John Dewrance, G.B.E.; Engineer Vice-Admiral Sir George Goodwin, K.C.B., LL.D.; Engineer Vice-Admiral Sir Henry J. Oram, K.C.B., F.R.S.; Leonard Sumner, O.B.E., M.Sc.; and Professor T. Turner, M.Sc., A.R.S.M.

Proposals were made during the year for the transfer to the British Non-Ferrous Metals Research Association of the control of the research which has been conducted continuously by the Corrosion Research Committee of the Institute of Metals since 1910. Henceforth the work will be controlled, directed and financed by the Research Association. It will be continued on its present general lines by the Investigator, Mr. R. May, A.R.S.M., working in the laboratories of the Royal School of Mines under the supervision and guidance of Professor Sir Harold Carpenter. In order to mark the origin and continuity

of the work it has been suggested by the Research Association that the investigation should in future be known as "The Institute of Metals Corrosion Research."

GREETINGS FROM GERMANY.

Dr. Georg Masing, representing the Deutsche Gesellschaft für Metallkunde, one of the bodies which acted as hosts of the Institute during the Düsseldorf meeting, conveyed greetings to the Institute and best wishes for a successful meeting.

Professor F. Körber expressed regret on behalf of the Burgermeister of Düsseldorf that the latter was unable to attend the London meeting in response to the invitation extended to him by the Institute, and conveyed his best wishes and his appreciation of the benefit he and his colleagues had derived from contact with British metallurgists in Düsseldorf last year. Professor Körber added that he hoped the contact thus established would become closer year by year to the benefit of metallurgy.

The Council's report was then adopted.

HON. TREASURER'S REPORT.

Mr. John Fry, Hon. Treasurer of the Institute, presented his report for the financial year ended June 30th, 1929, and moved its adoption. He pointed out that whilst there was a balance, the margin between income and expenditure was far too close. He urged the present members to invite their qualified friends to become members.

A suggestion made by Dr. H. J. Gough, who seconded the adoption, was that members might be asked to contribute a small sum each year for five years in order to build up a reserve fund to meet emergencies, as the Hon. Treasurer desired. He had in mind an annual contribution of 2s. per member, which would amount to £1000 in five years. He made the suggestion because increase of membership in itself would not necessarily result in the building up of an adequate reserve.

The report was then adopted.

OFFICERS FOR 1930.

The following members were declared elected to fill vacancies in the positions indicated for the year 1930:—President: Dr. R. Seligman. Vice-presidents: Mr. W. R. Barclay, O.B.E., Dr. R. S. Hutton, Engineer Vice-Admiral R. W. Skelton, C.B., C.B.E., D.S.O. Members of Council: Mr. Wesley Lambert, A.K.C., Mr. H. C. Lancaster, Mr. A. H. Mundey, Mr. A. J. G. Smout, Professor F. C. Thompson, Mr. F. Tomlinson.

INDUCTION OF THE NEW PRESIDENT.

The retiring President, Dr. Walter Rosenhain, then introduced his successor, Dr. Seligman, to whom he referred as a man of very great activity and the greatest possible keenness, and one whose great capacity and experience of administration would enable him to carry forward the work of the Institute in a most satisfactory and distinguished manner. He was elected in accordance with the system of rotation to which the Institute had adhered throughout of electing in turn a scientific investigator, a manufacturer and a user of non-ferrous metals. Strictly speaking, the new President was to be regarded as a manufacturer at the moment, but it would have been quite possible to have elected him as a scientific investigator, inasmuch as he had worked for a long time in a scientific capacity. In view of his early work on the Continent, where he had obtained a science degree, he would bring to the Institute certain contacts and experience which were likely to be very fruitful and happy in their results.

Dr. Seligman then formally occupied the chair, amid prolonged applause.

Prof. D. Hanson proposed a very hearty vote of thanks to Dr. Rosenhain for his services as President during the past two years. The vote was seconded by Prof. F. C. Thompson, supported by Sir Henry Fowler, and was carried with acclamation.

Dr. Rosenhain, in the course of his response, referred particularly to international collaboration, and said that on Tuesday, March 11th, at his invitation, a conference had been held in the rooms of the Institute at which a plan was elaborated for systematic international collaboration in regard to metallurgical research which he hoped would bear valuable fruit during the current year.

The President then delivered his presidential address, from which a long abstract is printed on page 294.

Prof. Ros, on behalf of the Swiss Association for Testing Metals, extended a hearty invitation to the Institute to hold its autumn meeting in September, 1931, in Zurich, and assured the members of a cordial welcome. He added that, inasmuch as the International Society for Testing Materials was to meet in Zurich at that time, the Association felt it would be fitting if the Institute of Metals had its meeting there also.

The President accepted the invitation on behalf of the Institute and expressed thanks to the Swiss Association.

The presentation and discussion of papers was then begun.

ANNUAL DINNER.

The Institute held its annual dinner and dance on Wednesday evening at the Hotel Metropole, London. About 350 members and guests were present under the chairmanship of the President, Dr. Richard Seligman. The toast of "The Institute of Metals" was proposed by Col. The Master of Sempill, President of the Royal Aeronautical Society, and was acknowledged by Dr. Seligman. "The Guests," proposed by Dr. Rosenhain, past-president, was responded to by Lieut.-Col. Sir Arnold Wilson, Col. Sir James Lithgow, President of the Institution of Engineers and Shipbuilders in Scotland, and by Mr. Pendred, President of the Institution of Mechanical Engineers.

(To be continued.)

Literature.

Centenary History of the Liverpool and Manchester Railway. By C. F. DENDY MARSHALL. London: The Locomotive Publishing Company, Ltd. 1930. Price 30s. net.

ON September 15th, 1830, the line between Liverpool and Manchester was opened, and the railway era began. There were other iron railways before it, but it may justly be regarded as the first thoroughly organised undertaking, designed specifically for steam traction in the whole world. It showed, as Mr. Dendy Marshall says, "what could be done, and led to the greatest changes in the habits of mankind that has ever come about otherwise than by a process of slow and gradual evolution."

The author of this very handsome volume is a recognised authority upon the Liverpool and Manchester Railway, and is the happy possessor not only of a very complete library upon the subject, but many relics, souvenirs, and pictures connected with it. No man was better qualified to write a centenary history, and he is to be congratulated upon the production and upon his publishers, who have, clearly, spared no pains upon the work. The volume contains many tone and line illustrations, but, apart from the text, it is chiefly remarkable for the large number of reproductions in colours of famous aquatint plates and lithographs, and for one other thing.

Some time ago Mr. Dendy Marshall was fortunate enough to secure the note-book used by John Rastrick, one of the judges at the Rainhill Trials. This note-book measures 4½in. by 6¾in., and is full of interesting data and sketches. It is one of the most valuable contemporary documents in existence concerning the Rainhill Trials, which, as everyone knows, settled the system of traction for the Liverpool and Manchester Railway, All who take an interest in railway history will be obliged to Mr. Dendy Marshall for publishing many pages from it—two in facsimile, but for some reason enlarged—in an Appendix.

For the rest, much need not be said. The text is composed from notes which the author has culled from an extensive literature, of which he gives a useful bibliography, and by descriptions—which will appeal to the collector—of pottery, medals, handkerchiefs, and even printed chintz which were produced when the country could never hear too much about the wonderful new means of locomotion.

The Balancing of Oil Engines. By W. K. WILSON, B.Sc. (London). London: C. Griffin and Co., Ltd. 1930. Price 25s.

WELL-KNOWN dynamical principles relating to the forces and couples acting on an engine frame in consequence of the motion of the parts are developed in Chapter I. of this volume. The expression for the accelerating force of the reciprocating masses, expanded into a trigonometrical series, is given, together with a table of the coefficients as far as the 6 θ term, but without any hint of how the coefficients may be obtained or without reference to their origin. The coefficients given are, in fact, those originated by McAlpine in an article in *Engineering* as long ago as October 22nd, 1897. In this article McAlpine also investigated the values of the coefficients for other periodic functions of the motion, including, for example, the turning moment. The omission is not of importance, since the author follows the usual practice of using only the first two terms of the series for the calculation of the acceleration of the reciprocating masses, and with this restriction the calculation of the expression is simple. The chapter abounds with tabulated data, which throughout form a useful feature of the book.

The "Balance Tabulation" of four and six-cylinder engines occupies Chapters 2 and 3, which are followed by chapters separately devoted to the problems of single-cylinder, two-cylinder, three-cylinder, four-cylinder, five-cylinder, six-cylinder, and, omitting seven-cylinder, eight-cylinder engines.

Since the author believes that the problems of the oil engine are susceptible of easy mathematical treatment, the engines being simple in form, he develops them up to the end of Chapter 10 mathematically. The many numerical tables distributed through the chapters give much arithmetical assistance in working out special problems and save the designer time and trouble once he has defined his problem.

In Chapter 11 there is given a somewhat incomplete explanation of the semi-graphical method of solving balancing problems put forward by Professor Dalby in a paper read at the Institution of Naval Architects in 1899, and since generally made known in his book on "The Balancing of Engines." It is true that the author makes no acknowledgment of the origin of the graphical method he explains, but he adopts the reference plane, and the vector polygons, and the rules for drawing vectors, but he leaves out the schedule. This is probably an oversight, but the schedule is an important part of the method, in that it reduces the data used in the problem to an orderly record.

The graphical method has the advantage over the arithmetical method preferred by the author, in that it is self-checking in the sense that a reciprocal figure is self-checking. In symmetrical multi-cylinder engines it is directly self-checking. In asymmetrical multi-cylinder engines balance weights or balancing arrangements can be checked by repeating the work from a new position of the reference plane. In complicated balancing problems it is of great advantage to have some means of checking the work, and whether it is done, as the author prefers, after an arithmetical computation has been made, by a graphical process, or whether the whole work is done by a graphical process and checked by a graphical process, is immaterial, providing it is checked.

There are so many practical limitations involved in the balancing of an engine that the graphical method is generally more than accurate enough.

The last chapter on Engine Foundations is of much interest. The author discusses the response of foundations to vibrations from engines of various types and gives in tables data of great value. He deals with such problems as anti-vibration foundations, isolated foundations, spring isolated foundations, and on page 258 he introduces the subject of forced vibrations. The main phenomena of such vibrations are stated, but the results would probably be more convincing to students if the author had had room for a more extended treatment of the fundamental principles.

The book will be useful to designers dealing with the simple problems of the balancing of the oil engine to which the author pays special attention.

Principles of the Absolute Block System. By L. H. KIRKNESS, Senior Deputy Traffic Manager, Madras and Southern Mahratta Railway. Calcutta: Government of India Central Publication Branch. Technical Paper No. 266. Rs. 2, or 2s. 9d.

THE last available report of the Indian Railway Board showed that over 800,000 persons were employed on the railways of India, and from an appendix to that report it appears that only 5000 or so of these persons were Europeans. It follows, since the operation of trains is so dependent upon the native element, that the rules and regulations must be more detailed than is necessary on, for instance, the railways at home.

We spoke in our Railway Matters column of November 22nd last, of the formidable size of the new standard rule book adopted by the Indian railways as from July 1st, 1929. It consists of 114 pages, foolscap size, 400 headings, 412 rules, four appendices, and an index of 30 pages. The present work may be considered as a necessary supplement to that part of the rule book which deals with the block system, including therein the various block instruments and apparatus for working points and signals.

The matter of the present volume has been compiled from lecture notes originally prepared by the author to teach the staff under him the principles of the absolute block system. Each rule, under the particular heading concerned, is explained as to its intentions, and how its purpose is achieved, and sketches are given to make the explanation yet more clear. The work in every respect does credit to its author, and must prove of no little value to all those on whom the operation of trains in India depends.

SHORT NOTICES.

Injuries to Workmen, The Law Relating to. By Frederick George Neave and Grange Turner. Fourth edition. London: Effingham Wilson. 1930. Price 6s.—It is often said that the lawyer has no better friend than books, which seem to make the mysteries of the courts plain to the man in the street. Nevertheless, every man is presumed to know the laws of the country in which at any moment he finds himself, and though that is very far from the fact, yet it is necessary that each man should be acquainted with the fundamental principles, at least, of the law as it affects his business. He may, not unreasonably, despair of ever knowing what interpretation of the law may be given by any particular judge, and he cannot help feeling grave anxiety as to the decision at which a jury may arrive, but if he is wholly unfamiliar with the statutes which affect his affairs and the decisions based upon those statutes, he runs a graver risk than even a merely superficial knowledge may engender. After all, one need not be litigious. The book before us, now in its fourth edition, endeavours to state, in non-technical language, what are the rights of the injured workman at common law and under the Acts of 1880, 1897 and 1900. It is a lucid little work and one that employers may read with advantage, since it is necessary that they should be familiar with their liabilities and, equally, that they should know the circumstances in which they are not liable if a workman incurs injuries. Many effective examples are given, and the explanation of the law and the interpretations which have been placed upon the clauses of the Acts are well set forth.

The Relative Safety of Mild and High-tensile Alloy Steels under Alternating and Pulsating Stresses.*

By BERNARD P. HAIGH, D.Sc.

(*Concluded from page* 263.)

Factors of Safety for Stress Concentrations.

In calculating "working stresses," it is customary to employ formulæ that take account of the main dimensions of the parts that are being designed, but disregard many minor features—radii of fillets and the like. The formula already mentioned for giving the stress in a Wöhler test

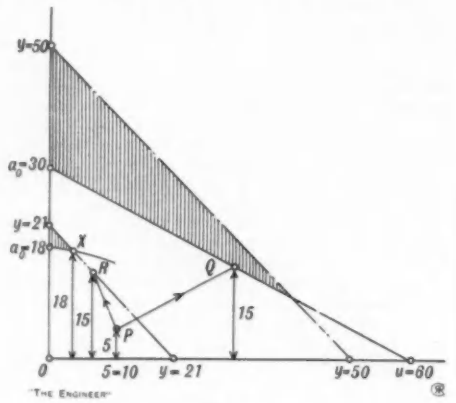


FIG. 13

piece is an example. It takes account of the leverage and diameter of the test piece, but disregards the curvature of the profile and the sharpness of any fillet that may be near the section of the fracture.

When parts of machines or structures have sharp fillets or are complex in profile, the true values of the stresses are often very different from the nominal values calculated by the use of such formulæ. To cover these discrepancies, as well as other effects that remain more or less unknown, it is customary to employ "factors of safety" of which the values are based—where possible—upon experience.

In mild steel, where plastic failure is so often the only type of failure that need be considered, a moderate factor of safety is often sufficient to cover the effect of stress concentrations caused by ordinary irregularities of profile, but in other metals, and especially where the circumstances are such that fatigue cracking is likely to be the type of failure actually in question, it may be necessary to allow higher factors of safety.

The influence of stress concentrations has been investigated experimentally and also mathematically—for, in some cases, the ratio of increase of stress can be calculated. For example, if a small round hole be drilled in a flat plate subject to uniform tension, the greatest intensity of stress at the edge of the hole can be calculated to be no less than three times as great as the nominal uniform stress in the plate—assuming that the metal is ideally elastic. The same ratio of stress-concentration has been found also by other theoretical methods of analysis.

Much uncertainty has been expressed from time to time as to the practical importance of such stress-concentrations. Some engineers, having experience of mild steel, may have been inclined to ridicule the idea, while others have assumed that the 3 : 1 ratio indicated by mathematical analysis must be applicable in all cases. In two series of investigations carried out in the Royal Naval College, Greenwich, it was found that the drilling of a small hole in a flat plate weakened the test piece only very slightly in some cases, and in ratio 2 : 1 or more in others. Such widely different results appear to deserve explanation as well as mere record.

It is proposed to consider in detail the influence of a small round hole, first in a plate of strong highly elastic steel, and afterwards in a plate of ductile mild steel, and, for this purpose, to employ again the two diagrams shown in Fig. 12 *ante*, representing extreme types of metal. Fig. 13 reproduces in a single diagram the two sets of graphs that were originally drawn separately, and shows a point P corresponding to $s=10$ and $a=5$. It is proposed to contrast the behaviours of the two metals in a plate worked with these nominal stresses.

If a small hole is drilled in the strong highly elastic plate, the concentration of stress at the hole will reach the values represented by the point Q, namely, $s'=30$ and $a'=15$, and as this point Q lies on the fatigue line of the metal in question, the plate will eventually crack from fatigue in spite of the high factor of safety represented by—

$$\frac{u}{(s+a)}=\frac{60}{10+5}=4.$$

Cracks will start from the sides of the hole, and will spread across the plate. The drilled elastic plate cannot, in fact, stand nominal stresses higher than $s=10$, $a=5$.

In contrast, suppose that the mild ductile plate is working with the same nominal stresses represented by P, these values being reached gradually. Before these stresses are reached—in fact, when the nominal stresses are smaller in the ratio of 21 : 45—the metal at the edge of the hole will begin to yield in a plastic manner, because the sum of s' and a' will then already have reached the yield point

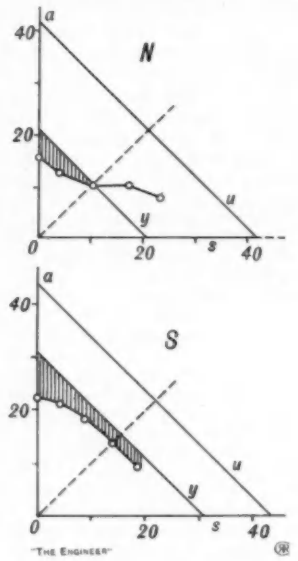


FIG. 14

21 tons per square inch. As a consequence, the distribution of stress will change, and will continue to change while the nominal stresses gradually increase to the values $s=10$ and $a=5$. The change will be such that the sum $(s'+a')$, at the edge of the hole, never exceeds the yield point $y=21$. The range at the edge of the hole will, indeed, attain the value indicated by mathematical analysis, namely, $a'=3a$, but the steady stress will be obliged to fall to $s'=y-3a$ at the edge of the hole, although elsewhere, of course, it will attain a value somewhat greater than the nominal value s. Thus when a reaches the nominal value 5, a' will be 15 and s' will fall to $21-15=6$ at the edge of the hole.

The revised stress $s'=6$ and $a'=15$ is represented by the point R, which lies on the yield line, but still well below the fatigue line in the diagram. In fact, the nominal stresses could be further increased to $s=12$ and $a=6$ before the local stresses would reach the values $s'=3$ and $a'=18$—represented by the point Q, which lies on the fatigue line as well as the yield line—before this ductile steel would eventually crack after continued repetition of stress. If the nominal stresses are increased in this way the ductile steel plate will, in fact, fail by cracking through the hole, although—without the hole—the nominal stresses could have been still further increased to $s=14$ and $a=7$, before the same metal would have failed by general plastic strain without cracking. Thus the reduction of strength caused by the hole is only very moderate in this ductile metal.

The contrast between these figures is seen in Table II., in which the values are in tons per square inch :—

TABLE II.

	High-tensile (more elastic)	Mild steel (ductile).
Ultimate tensile strength	60	30
Tensile yield strength	50	21
Ordinary (±) fatigue strength ..	30	18
"Two to one" ratio stresses to cause failure in plate without hole	30+15 (cracking)	14+7 (yielding)
"Two to one" ratio stresses to cause failure in plate with small hole	10+5 (cracking)	12+6 (cracking)

For such "two to one" stresses, therefore, the drilled, mild steel plate is actually 20 per cent. stronger than a drilled highly elastic plate that is 100 per cent. stronger in ultimate tensile strength, 138 per cent. stronger in tensile yield, and 66 per cent. stronger in "ordinary" fatigue tests using equal pull and push stresses. This is an extreme case, but in such circumstances it is not surprising that many practical men have looked with suspicion upon incomplete test figures.

To obtain reliable comparisons between the fatigue strengths of different steels that will be used under pulsating stresses in service, the form of test piece shown in the fourth diagram in Fig. 3 *ante* offers special advantages. In this form of test piece a small hole is drilled in a flat strip with suitable ends. The results obtained often differ widely from those given by ordinary test pieces of simple cylindrical form, and approximate more closely to opinions that may be based on practical experience. It is considered that fatigue tests of this type might well be specified as proving tests where the importance of the work justifies the expense and time entailed.

Typical Diagrams for Different Metals.

In Figs. 9–10 *ante* and Figs. 14–17 the author's colleague Mr. F. W. Thorne has collected data published from time to time by different investigators, and has included none but tests in which the fatigue limits have been determined directly by runs with ranges of stress giving long endurances. In some instances, especially where the yield point of the metal was uncertain, the limit of proportionality has been plotted in a line at 45 deg., and in all cases the ultimate tensile strength is represented in the same manner, for reference purposes only, by a line at 45 deg. A chain line at 45 deg. through the origin serves to mark the condition $s=a$, corresponding to stresses that pulsate between zero and an upper limit, without changing their direction.

Fig. 9—already described as an example of the influence of the parabolic k_2 coefficient—refers to a mild steel containing 0·13 per cent. carbon, described in a report of the British Association, 1915. This mild steel is peculiar on account of the low value of the ratio a_0/u, and may be regarded as exhibiting an unusually large unsafe area in the diagram. It may be not without interest to note that this steel was selected for the investgation chiefly on account of this peculiarity—which renders the metal capable of exhibiting fatigue under a wider range of conditions than otherwise would be possible without undue yield. It is probable that ordinary mild steel of good quality is more truly represented by the hypothetical figures used in sketching Fig. 12 *ante*.

The naval brass represented in Fig. 10 was selected with the same consideration in view. Of several samples available at the time, as described in a paper contributed in 1917 to the Institute of Metals, it was the only one in which the ordinary fatigue limit a_0 was found to lie below the yield point. Even in this sample, however, the margin is only small; in most of the tests, therefore, with steady stresses acting in combination with alternating stresses, fatigue cracks could be produced only after the metal had yielded considerably—either by extending or by compressing in length during the test.

The two diagrams shown in Fig. 14 refer to two series of tests carried out by Moore and Jasper.* The same steel, containing 0·49 per cent. carbon, was tested after two different heat treatments, giving normalised and sorbitic structures respectively, corresponding to two diagrams marked N and S. Although the sorbitic structure gives the higher fatigue limits, as well as the higher yield point and ultimate tensile strength, a large portion of its safe zone is bounded by the fatigue graph. It may be inferred, therefore, that the sorbitic structure is more likely to fatigue in practice, although the stresses required to crack it are greater than those required to produce plastic yield in the normalised sample.

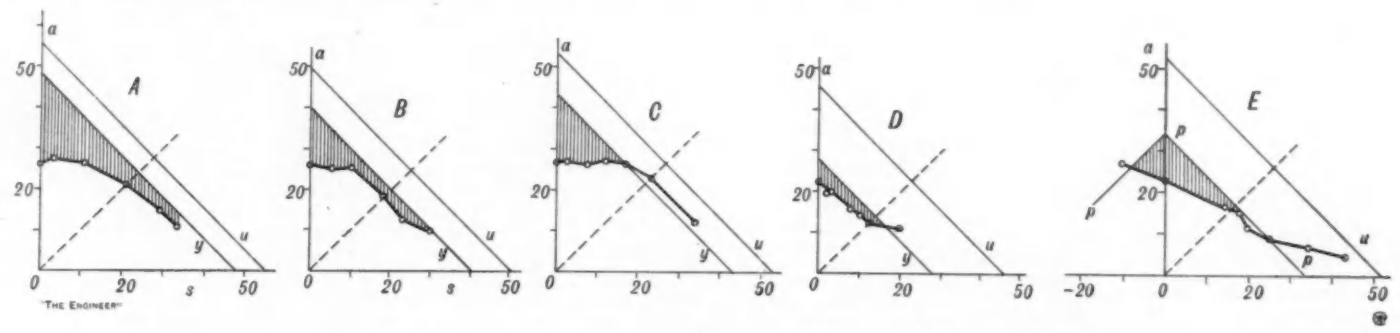


FIG. 15

Fig. 15 represents five series of tests on nickel-chromium steels containing about 3¼ per cent. nickel. Four diagrams, A, B, C, and D, refer to a single steel containing 3·41 per cent. nickel, 0·18 per cent. chromium, and 0·41 per cent. carbon, tested by Moore and Jasper.† Different heat treatments were used, samples A, B, and C being annealed, reheated, and quenched in different ways, and then reheated. All were cooled slowly in the furnace. Sample C had a complex heat treatment, and it is evident that this has appreciably improved the fatigue-resisting properties of the metal, although the nominal test values for a_0, y and u differ only very slightly from the values for sample B. The contrast between the two diagrams shows very clearly that the three familiar test figures, even including the value of a_0, do not, in fact, suffice to indicate the relative liabilities to fatigue under the stresses that are found so commonly in practice. Diagram D refers to samples that were simply heated to 1445 deg. Fah., held at this temperature for one hour, and then cooled in the furnace. It is notable that the omission of quenching and tempering has distinctly lowered the resistance to fatigue without greatly changing the general character of the fatigue graph.

Fig. 15 diagram E,, refers to a nickel-chromium steel

* Institution of Automobile Engineers, London, February 4th.

* See Bulletin No. 136, University of Illinois, 1923.

† See Bulletin No. 136, University of Illinois.

tested by Professor F. C. Lea and Mr. H. P. Budgen.‡ The analysis of this steel includes 3·6 per cent. nickel, 0·6 per cent. chromium and 0·3 per cent. carbon. Tests were carried out with alternating stresses in combination with steady stresses up to unusually high values that must have produced considerable plastic strain. A straight line can be drawn roughly through all the points, corresponding to k_1, about 0·43, but Mr. F. W. Thorne has drawn the author's attention to an interesting feature that is illustrated even more clearly when the same experimental results—quoted in full in the reference mentioned—are plotted on a larger scale that enables a comparison to be made between the endurances in the several tests. It apppears that the fatigue results in this case, as in many others, do not plot on any continuous graph when plastic strain occurs during the course of the test. There is commonly a discontinuity that may be upward or downward in different cases, indicating that plastic strain affects the value of the fatigue limit. Such discontinuities are evident in several of the diagrams plotted, *e.g.*, in Fig. 14 for the normalised carbon steel tested by Moore and Jasper; but Professor Lea's work affords a particularly clear illustration when plotted in detail, owing to the large number of tests carried out with stress combinations in or near to the zone in question—where the fatigue line reaches the limit for plastic strain. In this diagram no yield line has been plotted, but a 45 deg. line *p p* represents the limit of proportionality observed in a tensile test, and it appears that the discontinuity in the fatigue graph occurs where it meets this line. It is considered that this feature is of theoretical interest and value—indicating that plastic strain has a slight but definite influence on the course of the action that leads to fatigue fracture.

‡ See Aeronautical Research Committee, Report No. 920.

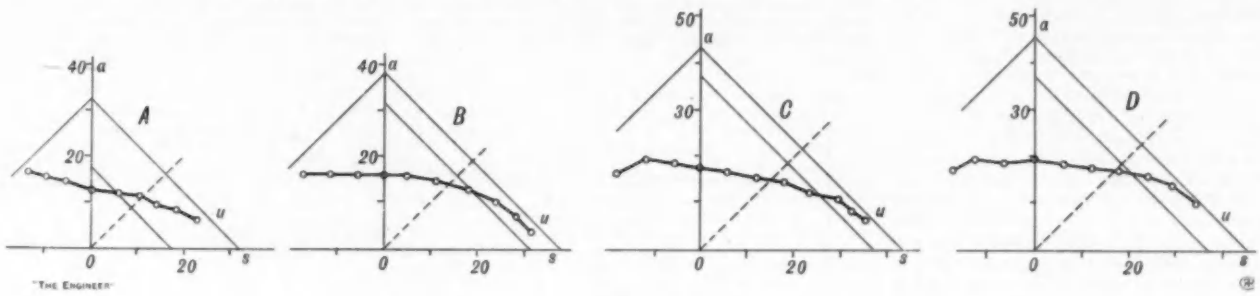


FIG. 16

It appears that no empirical expression, such as the formula $a_s = a_0(1 - k_1(s/u) - k_2(s/u)^2)$, can suffice to express all the features revealed in graphs plotted from the results of tests carried out with adequate care. Certain of the graphs, that have long been regarded as approximate parabolas, may be appreciably different—and of greater theoretical interest—when studied in detail to show the influence of plastic strain.

Fig. 16 represents four series of tests carried out by Dr. R. M. Brown in Glasgow.* One and the same steel, containing 0·29 per cent. carbon, 0·52 per cent. manganese, and 0·10 per cent. silicon was used for all these tests, which were designed to investigate the effect of cold working. The annealed bars, 0·6in. diameter, were drawn through round dies lubricated with soap, the rate of drawing being 3·3 inch-minutes in all cases. Three sets of dies were used to produce 11 per cent., 23 per cent., and 35 per cent. reduction of cross section. Diagram A represents the metal in its initial annealed state, while diagrams B, C, and D refer to tests on the samples with the three different reductions of area. In each case, the full reduction of area was obtained in a single pass through the dies.

* See *Journ.* Eng. and S. in Scotland, 1928.

The 45 deg. lines in these diagrams represent (1) the "proof" stresses defined as the tensile stresses required to produce only 0·1 per cent. permanent strain—a value much lower than the 0·5 per cent. which is customarily used as the basis of definition for proof stress in mild steel—and (2) the ultimate tensile strength observed in tests carried out on pieces that had not been tested in fatigue. Somewhat higher ultimates are recorded by Dr. Brown in tensile tests on pieces that remained unbroken after long fatigue tests with endurances up to 30 million cycles. The graphs show that cold working raises the fatigue limit consistently, although in less degree than it raises the proof stress or the ultimate tensile.

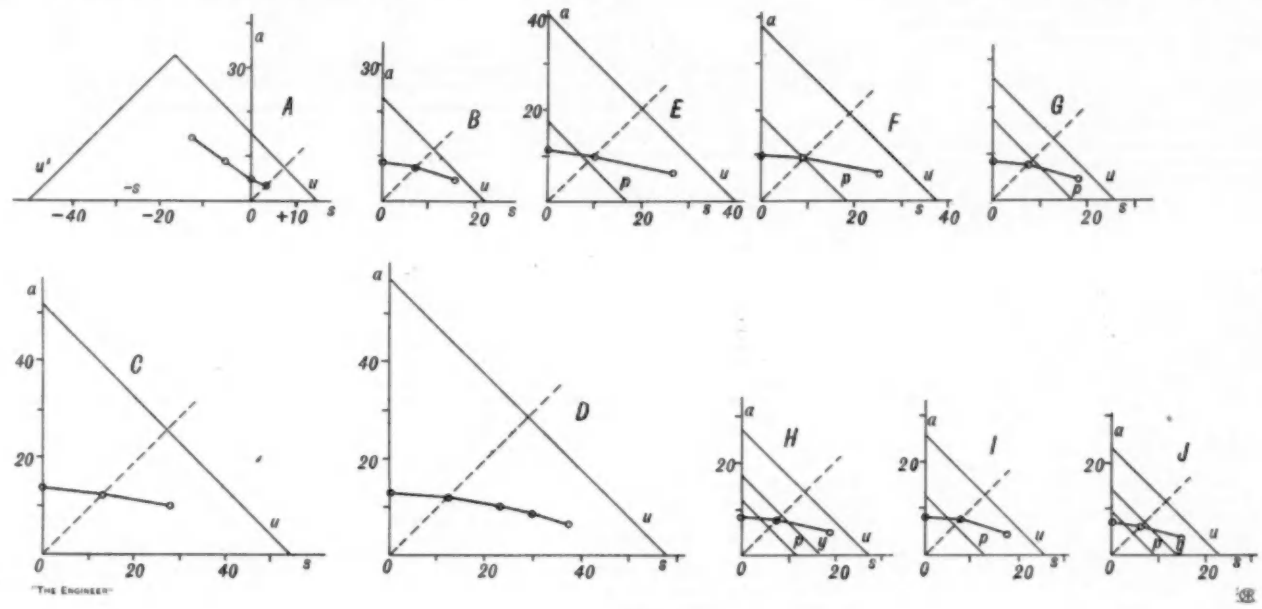


FIG. 17

Fig. 17 represents tests carried out by Moore, Lyon, and Inglis† on cast iron with tensile ultimate 13·8 and compressive ultimate 49·5 tons per square inch. The analysis includes 2·76 per cent. graphitic carbon and 0·68 combined carbon, with 0·62 per cent. manganese, and the microstructure shows lamellar pearlite and graphite. The fatigue graph slopes steeply and shows that the metal resists fatigue effectively when the steady stress acts as compression.

In Fig. 17, diagrams B, C, and D represent early work by Wöhler,* described in Unwin's "Strength of Materials," while diagrams E, F, G, H, I, and J show Bauschinger's work,† described by Unwin. It was on the basis of this early work that the parabolic formula—corresponding to a coefficient k_2 without k_1—was advanced by Gerber as a sufficient description of the influence of steady stress in combination with alternating stress.

Table III. gives data for the several metals mentioned, together with approximate values of k_1 and k_2 to fit the plotted graphs.

TABLE III.

Figure and diagram.	Material.	Tensile ultimate *u*, Ton per sq. in.	Tensile yield point *y*, Ton per sq. in.	Ordinary fatigue limit, A_0 Ton per sq. in.	Coefficients. k_1.	Coefficients. k_2.
9	Mild steel	25·2	21·0	13·0	0	1
10	Naval brass	28·7	14·5	12·0	1	0
14N	0·49 C norm.	40·9	21·05	14·7	1	0
14S	" sorbitic	43·3	31·2	21·5	0·16	2·5
15A	3¼% Ni steel	55·0	48·5*	26·8	0	1·47
15B	"	49·8	40·6*	26·8	0	2·26
15C	"	52·5	42·1*	26·8	—	—
15D	"	45·3	28·9*	22·0	1·37	0
15E	3·6% Ni steel	51·3	34·7*	23·0	1	0
16A	0·29% Ann	32·3	17·4†	13·0	0·57	0
16B	HD. 11%	38·3	32·2†	15·6	0·05	0·75 (tension) 0 (compression)
16C	HD. 23%	43·6	38·0†	18·0	0·1	0·75
16D	HD. 35%	46·3	37·5†	19·0	0	0·795
17A	Cast iron	14·1	—	4·5	1·6	−0·6
17B	Phœnix iron	22·8	—	8·6	0	1
17C	Axle steel	52·0	—	14·0	0	1
17D	Untemp. spring	57·5	—	13·4	0	1
17E	Axle steel	40·0	17·6*	10·5	0	1
17F	Rail steel	39·0	19·0*	9·7	0	1
17G	Boiler plate	26·6	17·6*	8·6	0	1
17H	Bessemer steel	28·6	17·4	8·5	0	1
17I	Bar iron	26·6	11·8*	7·8	0	1
17J	Wrought iron	22·8	14·5	7·1	0	1

* Limit of proportionality or elastic limit.
† Proof stress.

† See Bulletin No. 164 of University of Illinois.
* See also *Engineering*, Vol. XI.
† See also THE ENGINEER, 1866 and 1867.

In the course of a paper on the cleaning of coal, read before a joint meeting of the Society of Chemical Industry and the Institute of Fuel, Messrs. F. S. Sinnatt and D. T. Davies said: "Some consideration must be given to the amount of chlorine in coal before deciding upon the system of cleaning to be adopted. In the past the question of chlorine has been of particular interest to those engaged in the manufacture of coke, but coal suitable for steam raising not infrequently contains fairly large percentages of chlorine. Chlorine occurs combined with the organic substance of coal and as chlorides of sodium and magnesium, &c. The amount present may vary from one locality to another in the same seam, and in one particular instance a seam was found to contain from less than 0·1 per cent. of sodium chloride at one place to over 1 per cent. in a neighbouring locality. Our knowledge of the *rôle* played by chlorine during the combustion of the coal in furnaces is incomplete, but since in certain cases it may be highly desirable to reduce the amount of chlorine in the cleaned grades, it is obvious that dry cleaning methods are not so suitable as wet. The only practical method of removing the salt from coal is by solution in water. When such coals are being treated it necessitates frequent renewal of the whole of the washery water."

Pulverised Fuel at Sea— The "Hororata" Installation.

IN a Journal note which appeared in last week's issue we made a short reference to our inspection at Millwall Docks of the new Howden-Buell pulverised fuel installation which has been recently completed by R. and H. Green and Silley Weir, Ltd., on board the s.s. "Hororata," belonging to the New Zealand Shipping Company, Ltd. It will be recalled that in THE ENGINEER of December 14th, 1928, we described the installation of pulverised fuel on the three forward boilers, and since that date the ship has completed nearly 60,000 miles with great success. With the exception of one of the boilers, which, according to the Board of Trade rules, must be hand fired, and will serve for emergency and port use, the other five boilers have now been equipped with Howden-Buell burners, and the opportunity has been taken to install five pulverising mills of an entirely new type, which has been developed by the firm and has already been subjected to exhaustive tests in the shops. The actual departure of the ship from Millwall after her inspection by a large party of engineers was delayed owing to lack of berthing facilities at Middlesbrough, and the opportunity was taken to "tune up" some of the shafting and transmission gearing driving the pulverising mills. Considering that the plant had only been completed a few days before the inspection, and that the main engines had also been completely overhauled, it is very satisfactory to learn that the voyage to Middlesbrough was made without incident, and that increasing speeds up to 12½ knots were recorded. There was, we understand, very little smoke and no sign of ashes on the decks. The "Hororata" is now awaiting cargo at Middlesbrough, and she will then sail from London for Panama and New Zealand. During the voyage an opportunity will be taken to record fully the performance of the new plant and special representatives of the firms of R. and H. Green and Silley Weir, Ltd., and Howden-Buell Combustion Company, Ltd., are to travel with the ship for the purpose of making the tests. In a later article we hope to publish the complete voyage results.

The "Hororata" is a twin-screw passenger and cargo ship of about 11,243 gross tons, and was built in 1914 by William Denny and Brothers, Ltd., at Dumbarton. Her propelling machinery comprises two sets of quadruple-expansion engines, taking steam from six single-ended, four-furnace, coal-fired, Scotch boilers, arranged back to back in two stokeholds. The boilers are fitted with Howden's standard forced draught system, with heated air. The pulverising plant—as shown in Figs. 1 and 2—is arranged in a space adjacent to the forward stokehold, which has been obtained by the removal of the cross bunker. The two original Fuller-Bonner ball mills have been removed, and in their place five of the new Howden-Buell mills have been installed, room being left for a further mill, should it at any time be required.

The coal from the bunkers is dumped on to a grid with a mesh of about 3in., and falls on to a belt conveyor below, which elevates it to the crushing mills. Both the crushers and the conveyors are operated by electric motors. The crushers were supplied by Fraser and Chalmers Engineering Works, and the rubber conveyor belts by the Silvertown Company. Incorporated with the elevator drives there are magnetic pulleys of the Witton-Kramer type, which effectually remove any metal in the coal, and so keep the mills free from such obstruction. The crushed coal is delivered to an overhead bunker, which contains sufficient fuel for a full steaming period of about twenty-four hours. Each of the five pulverising mills is fed from a chute leading to the hopper of the mill.

In Fig. 3 we reproduce a section through the mill. A vertical spindle design has been adopted with a series of cast steel balls running in a cast steel race. The speed of the mill is 40 to 45 r.p.m., and the running is noticeably quiet. Pressure is applied to the upper part of the race by means of a series of springs. The heated air from the Howden boiler fronts is led into the mill at the ball race level, and the races are air swept. All the finely ground coal is drawn up through the separators, while the larger particles fall back again and mix with the incoming coal. This action helps to dry the raw coal, and enables the mill to utilise moist fuels. All the bearings are totally enclosed, and to the left of the mill, Fig. 3, will be seen the variable speed coal-feeding arrangement. The mill is simple in its design, and the main parts are easily replaceable, while the floor space required is only 4 feet square and the total weight about 3 tons. The heated air laden with the coal dust is drawn off by the fuel fan and is delivered to the burners through a special distributor. As will be seen from Fig. 2, the mills are worked from a common line shaft, by means of enclosed chain drives, and each mill is furnished with a clutch, so that it can be isolated when required. The main shaft is coupled through Humphrey-Sandberg clutches to two high-speed Howden compound engines, one of which is a stand-by unit.

During the voyage from London to Middlesbrough an opportunity was taken to test the flexibility and the manœuvring capabilities of the installation with all five mills running. It was found that the supply of steam to the main engines could be easily controlled by cutting down the supply of coal to each mill between the limits of 1500 lb. and 150 lb. per hour, and the supply quickly increased by raising the quantity of fuel delivered. The mills were worked at a temperature between 160 deg. and 180 deg. Fah., the powdered fuel being delivered to the furnaces at a temperature of about 150 deg. Fah. A feature of the trials, we learn, was the consistent fine grinding of the mills, which delivered practically 100 per cent. through a 100 mesh screen, with resulting steady combustion.

A section through the Howden-Buell distributor is shown in the upper part of Fig. 4. It will be seen that the fuel is guided by a series of small adjustable blades, which can be altered as regards their angle to each other and the direction of flow of the air and coal stream. The supply of fuel to any one of the four burners can also be cut off by the hinged flaps at the top of the distributor, which control the air and coal streams. In practice it has been found that there is no real distribution problem, and when the ship leaves port no further adjustment of the distributor blades has been found necessary.

In the lower part of Fig. 4 we show a section through the triple-flow dispersive type of Howden-Buell burner, which has not been altered in design since the first burners were installed in the ship. The axis of the burner is placed practically on or a little above the centre line of the furnace, and the fuel enters the burner through a helical-shaped body, which discharges it into an annulus formed by two concentric tubes. The fuel stream is thus given a rotary motion and the bell-mouthed centre tube causes it to be discharged at a tangent to the annulus, resulting in a short flame. Secondary air from the Howden casing is supplied through perforated baffles, and at the centre of the burner there is also a supply of slow-moving heated air. At the front of the centre tube a sight glass is arranged which enables the character of the flame to be conveniently observed. Means for adjusting the position of the centre tube are also provided. As shown in Figs. 1 and 2, the fuel fan units are placed in the port and starboard wing spaces, and in the forward space near the pulveriser mills. They are of the Sturtevant pattern, and are driven by Greenwood and Batley De Laval type turbines. All the exhaust steam, both from the engine driving the mill shafting and the turbines driving the fuel fans, is passed through the Wyndham exhaust heating system, in which it is superheated in specially designed heaters placed in the uptakes. During the voyage to Middlesbrough it was demonstrated that the waste heat thus recovered could be very effectually utilised in raising the temperature of the boiler feed to some 260 deg. Fah. The remainder of the exhaust steam is, after being superheated, passed into the low-pressure casings of the main engines, where it

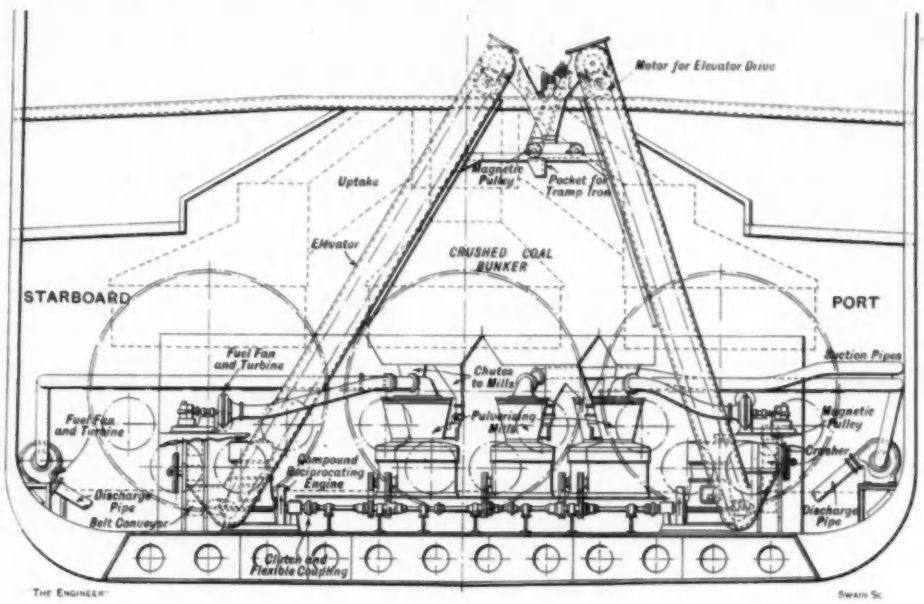


FIG. 2—PULVERISING PLANT LOOKING AFT FROM FORWARD BULKHEAD

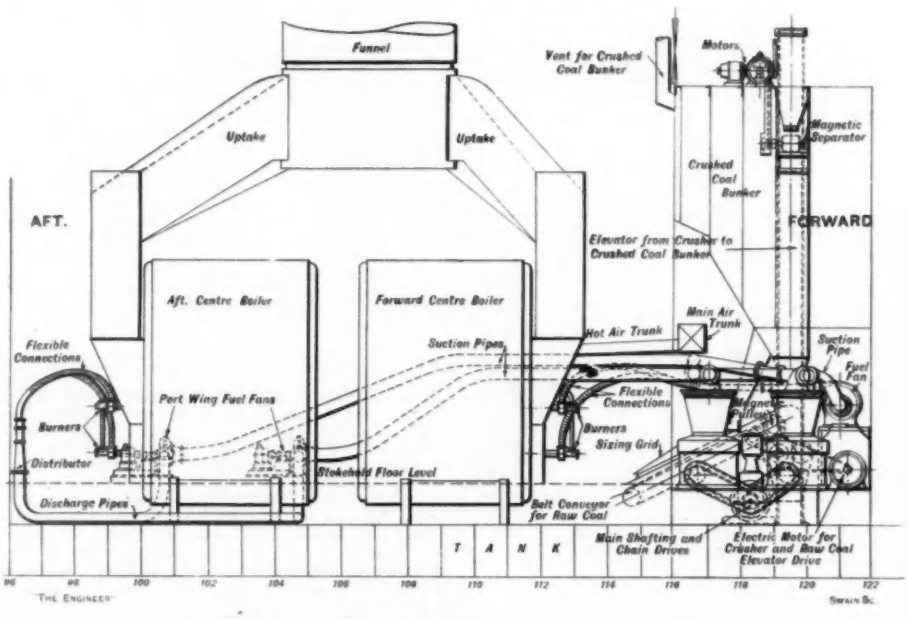


FIG. 1—ARRANGEMENT OF STOKEHOLDS AND PULVERISING PLANT

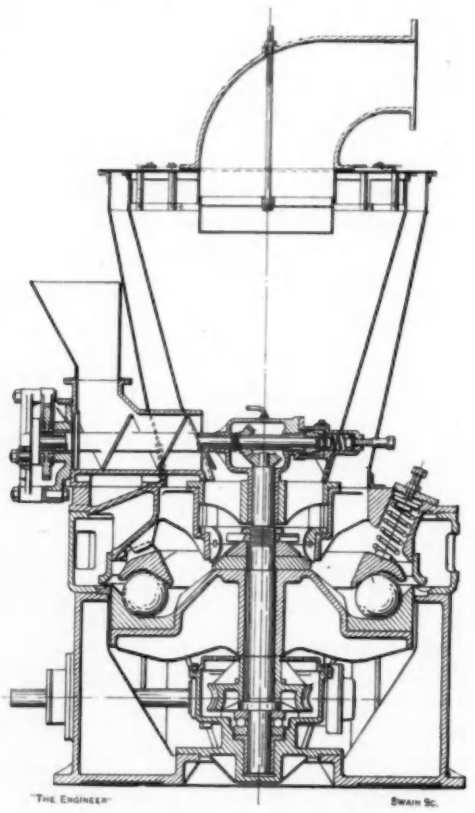
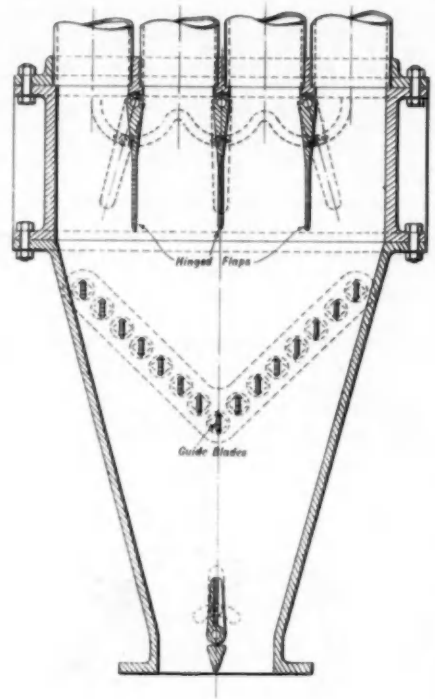


FIG. 3—SECTION THROUGH MILL

serves to dry the incoming supply of steam from the intermediate-pressure cylinders.

The installation we have described is characterised by its very neat arrangement and the comparatively small power—in the neighbourhood of 9 to 10 B.H.P.—which is required to drive each of the pulverising mills. The plant was very silent when in operation, and the combustion very steady, this being largely due, we were informed, to the consistent fine grinding maintained under all conditions of load. We noticed that the furnaces are only lined with refractory material for a distance of about 4ft. from the front of the furnace, and that the lining is carried round the top of the furnace and only partly down the sides. With this arrangement no difficulties of slagging have been met with, and the finely divided ash and slag can be withdrawn from the ashpits in the ordinary way. Soot blowers of the Diamond type are fitted to remove any dust from the return tubes, and in the smoke-boxes a special type of steam ejector designed by the firm



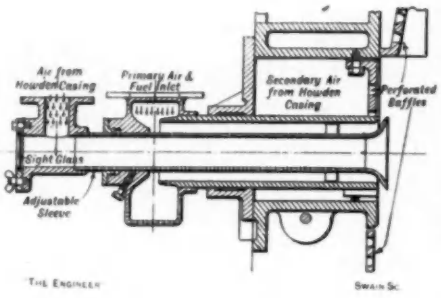


FIG. 4—DISTRIBUTOR AND BURNER

is employed to extract by suction any dust which may be deposited in the smoke-box spaces.

The complete installation we have described was favourably commented upon by many of those who inspected it at the Millwall Docks, and the performance results of the "Hororata" will be awaited with no little interest.

SIXTY YEARS AGO.

WE have on past occasions noted the parsimony with which Governments in former times rewarded the services of inventors whose ideas they had utilised. Our columns were always open to the publication of stories of oppression on the part of officialdom, and in our issue of March 18th, 1870, we find a characteristic report of injustice alleged to have been done by the War Office. It was reported to us by Mr. P. M. Parsons. Ten or eleven years previously the Government had decided that it would be a good thing if all its cast iron guns could be strengthened and rifled. Several gentlemen, including Sir William Armstrong, turned their attention to the subject, but after many experiments had been carried out and £45,000 had been spent on the idea, the attempt was given up in despair. Subsequently, the idea was revived in a different form. Success was achieved and numerous 68-pounder and other smooth-bore guns were strengthened, rifled, and issued for service. The inventor of the system of conversion was Mr. P. M. Parsons, or so we were convinced. He submitted his scheme to the War Office in May, 1860. His idea was to insert a wrought iron or steel tube inside the bore of the cast iron gun instead of hooping it externally. The plan was approved, and a trial 68-pounder gun was ordered to be converted. The Ordnance Select Committee decided, however, to carry out the scheme in its own way. It elected to heat the gun with the object of shrinking it on to the cold lining tube. The tube, it was found, stuck half way. Other troubles arose, and after wasting much time and money, the Committee decided to follow the plan suggested by Mr. Parsons, namely, to force the lining into a bored-out gun by hydraulic pressure. Two guns so converted were fired with considerable success. Mr. Parsons was not, however, allowed to participate in the conversion or the trials. He was even denied all official information as to what the Committee was doing, so much so that believing the idea to have been abandoned, he allowed his patent to lapse. Meanwhile, Captain Palliser introduced a method of conversion identical in all respects with Mr. Parsons' except that he inserted the tube from the breech end of the gun instead of from the muzzle end. In 1867 the War Office decided to make a further trial with Mr. Parsons' system, but the concession was only obtained by Mr. Parsons undertaking to pay for the gun if it failed to stand 1000 rounds with 30 lb. of powder and 150 lb. shot. The unfairness of this stipulation was made evident by the fact that 30 lb. was the ordinary service charge for a 12½-ton gun, whereas the converted gun to be tried weighed only 5½ tons. Mr. Parsons, however, had perforce to consent. He had even to consent to two of the rounds being fired with 37½ lb. of powder. The gun was overstrained. That it withstood 167 rounds with 30 lb. of powder in addition to the two with 37½ lb. was remarkable. The authorities, however, after the test informed Mr. Parsons that Captain Palliser's system answered all their requirements. Mr. Parsons had spent £7000 on his scheme. He was offered £1000 as recompense. Captain Palliser received a grant of £7500.

Canadian Engineering News.

(From our own Correspondent.)

New Locomotive.

DESIGNED to give a tractive effort of 83,200 lb., a new locomotive to be operated on a high steam pressure principle is being constructed at the Angus shops of the Canadian Pacific Railway. This tractive effort will be 5200 lb. more than that of the "5900" series, and 37,900 lb. greater than that of the "2800" series. Canadian material will be used in the building of the new engine, with the exception only of materials that are not procurable from Canadian manufacturers. The new locomotive will have a two-wheel leading truck, five pairs of driving wheels and a four-wheel trailing truck. It will be known as the Canadian Pacific Railway "T-4-a" class. The engine alone will weigh approximately 466,500 lb., and the tender 297,500 lb., making a total weight of 764,000 lb., or 341 tons—14,000 lb. heavier than the "5900's" and 100,000 lb. heavier than the "2800's." The locomotives will have three cylinders, the high-pressure or centre cylinder being 15½in. diameter by 28in. stroke, and the two outer low-pressure cylinders 24in. diameter by 30in. stroke. The tender will be almost an exact duplicate of existing types in use, and will have an oil fuel capacity of 4100 Imperial gallons and a water capacity of 12,000 Imperial gallons.

Grain Facilities.

The principal contract to be undertaken by the Canada Steamship Lines, Ltd., this year will be the completion of a grain elevator at Kingston, Ontario. This structure will have a capacity of 2,500,000 bushels, and will cost approximately 3,000,000 dollars. It is to be ready for the opening of the new Welland Canal. Considerable work has already been done on the plant and construction will proceed throughout the winter. Two travelling marine towers, each having a capacity of 35,000 bushels per hour on the dip will comprise the unloading facilities. Unloading capacity of the initial unit will be about 800,000 bushels a day. The largest grain ships on the Upper Lakes will find ample accommodation at the unloading dock, which is 700ft. long and 300ft. wide. The travelling marine towers can reach any hold without shifting the vessels.

Railway Development.

The year 1929 was an important one from the standpoint of railway development in the Dominion, as was foreshadowed by the construction programmes of the two principal railways at the last session of Parliament. At that session sanction was given thirteen branch line proposals of the Canadian Pacific Railway, covering a five-year programme, involving the construction of about 1200 miles of railway at an approximate cost of 50,000,000 dollars. The Canadian National Railway authorities were granted approval of their third three-year branch-line programme, involving seventeen projects and 701 miles of construction, at an estimated cost of 32,000,000 dollars. Two previous branch-line programmes, 1924 and 1927, involved an expenditure of 15,600,000 dollars and 18,600,000 dollars respectively. This means that by the end of 1931 more than 1800 miles of new branch line will have been constructed by the Canadian National Railways, at a total cost of more than 66,000,000 dollars. As the Canadian Pacific has been equally active, it is easy to believe the statement that an average of a mile and a quarter a day of new railway is being built in Canada.

Radium Ore.

Referring to the occurrence as the first vein of its kind to be discovered in Canada, the Federal Department of Mines reports that a definite uraninite bearing vein has been disclosed in Haliburton County, Ontario. The vein has been uncovered for a length of 150ft. by the removal of a light dirt cover, and has been traced by outcrops for a further 400ft. Its full length, however, has not yet been determined. The uraninite occurs as scattered crystals or nodular masses through the vein matter, some of the masses weighing several pounds. Several hundred acres of land around the discovery have been acquired by a Toronto syndicate, the Ontario Radium Corporation, Ltd., and the company intends to proceed with development.

Lignite Plant Successful.

Investigations commenced some years ago with the object of solving the problem of the utilisation of lignite deposits near Estevan in Southern Saskatchewan are proving successful. More than ten years ago the Dominion Government, together with the Governments of Manitoba and Saskatchewan, erected an experimental plant. Briquettes were made, though not successfully from an economic standpoint; and, after the expenditure of more than 1,000,000 dollars, the Dominion and Manitoba Governments withdrew in 1920, leaving the Government of Saskatchewan to deal with the situation alone. The plant remained idle for four years, although during that period inquiries were being conducted, as a result of which it was finally decided that the Lurgi process, which was invented by Dr. Hubman, should be given a trial. Accordingly, the plant was turned over to the Western Dominion Collieries, Ltd., of Winnipeg, and, in 1927 and 1928, as the preliminary tests had proved so successful, the erection of a new carbonising plant was commenced under the supervision of the inventor. Production began early in 1929 with a daily output of 100 tons, but that is being increased as required to 200 tons, and it is expected that the plant will shortly attain capacity production.

New Copper Refinery.

The Ontario Refining Company is making good progress with its new copper refinery at Copper Cliff, Ontario. The plant proper will have an initial capacity of 20,000,000 lb. of refined copper a month. The principal buildings will be a tank house, 480ft. by 340ft., the anode and wire bar casting buildings, each 150ft. by 400ft., machine shop, coal-pulverising plant, silver refinery, and office buildings. The tank house will contain 1216 lead-lined concrete tanks, with the usual heating and circulating system. There will be two electrolytic circuits, operating at about 160 volts and 11,000 ampères. Uniform temperature conditions will be maintained by means of six fans and heaters, placed at opposite ends of the tank house, which through a system of ducts will distribute fresh air throughout the building. Most of the power for the operation of the plant will come from the High Falls installation of the International Nickel Company of Canada, Ltd. The copper casting department will include two casting buildings, one for anodes and the other for refined copper shapes. Each building will be large enough to hold four 300-ton furnaces, but only three will be installed in each at first. All furnaces will be fired by powdered coal, which will be supplied from a central station. In the present installation, two pulverisers, each with a capacity of 6 tons an hour, and a dryer of ample capacity will be used.

Commercial Aviation.

Possibly in no other country is commercial aviation making such a contribution to progress as in Canada. Regions formerly regarded as inaccessible and otherwise doomed to remain for ever undeveloped are now not only being explored, but are actually in process of development practically wholly by means of aircraft. With a view to aiding this work, the National Research Council, in collaboration with the Department of the Federal Government directing commercial aviation, has begun the construction of National Aeronautical Research Laboratories at Ottawa. A function of the laboratories will be to test the airworthiness of aircraft engines manufactured in Canada, which until the present time it has been impossible to do because no equipment was available. Included in the new laboratories will be :—(1) A wind tunnel for aerodynamic research and testing, 9ft. in diameter, in which a 13ft. propeller will develop an air speed of over 125 miles per hour; (2) a towing tank, 400ft. long and 6ft. deep, for the testing of aeroplane floats, hulls, and other high-speed craft; (3) complete engine-testing plant, capable of accommodating aircraft engines of any type and of absorbing powers up to 1000 horse-power at speeds up to 2500 revolutions per minute.

Postal Machinery.

The Post Office Department has embarked upon a policy of designing and either making itself or having made in Canada all its postal equipment. The mechanical branch of the Post Office Department devised a stamp-cancelling machine, now in use in all the big offices, while it has also designed a conveyor system which makes about 90 per cent. of the process of mail handling mechanical. In former days it was necessary to import all this equipment or to pay royalty for the use of machines from the United States, but now it is all being made in Canada from departmental designs. A most elaborate system of conveyors is projected between the new postal terminal in Montreal and the Canadian National and Canadian Pacific stations.

Rural Electrification.

The complete electrification of rural Quebec is the objective of studies being carried out in that province. Three of the largest hydro-electric companies in the province are now studying new rate schedules for the rural areas designed to foster the freer use of power and current, and the outcome is being closely watched by experts who predict that, with genuinely attractive prices, the next decade will witness almost complete electrification of rural Quebec. At present, most of the agricultural areas are under schedules requiring two meters, with one rate for light and another for power. The scheme under study would involve but one meter, with an all-embracing schedule for both power and light, and a decreasing rate in proportion to fixed levels of consumption.

Aeroplane Clubs.

Figures just released by the Civil Aviation Branch of the Department of National Defence show that members of Canada's twenty-three light aeroplane clubs flew 15,400 hours during 1929. This flying time is equivalent to 1,232,000 miles, and is nearly twice that flown in 1928. Total membership of the clubs is 5092. At the end of the year there were 396 *ab initio* solo flyers, while 165 private pilots and 58 commercial pilots had graduated from the student ranks of the clubs. Comparative figures of 1928 show there were fifteen clubs, which flew 8124 hours, producing 209 solo flyers, 111 private pilots, and 28 commercial pilots.

Provisional Rules for Fusion-Welded Non-Fired Pressure Vessels.*

A LARGE number of tentative rules governing the construction of fusion-welded vessels has been framed. As the rules do not purport to cover requirements for a vessel when in service, attention is particularly drawn to the necessity for a vessel to be so situated and so equipped with sight-holes that both sides of all welded seams are readily accessible for inspection; the construction should also be such that all plate thicknesses can readily be gauged. A welded vessel should not be installed where the owner is unable, owing to exigencies of service or other cause, to grant facilities for inspection and hydrostatic test.

Amongst other important requirements are that a drain should be fitted at the bottommost point of a pressure vessel, and that a relief valve be mounted in an approved position, which in general will be on the vessel itself.

The rules are as follows :—

(1) *Scope of Rules.*—The rules apply to vessels containing air or non-corrosive gas at a temperature not exceeding 600 deg. Fah., more especially when the diameter does not exceed 36in. For vessels with a diameter not exceeding 20in., the rules do not apply when the working pressure is 30 lb. per square inch, or less.

(2) *Method of Welding.*—The rules are applicable to vessels welded by the metallic-arc process with a flux-coated electrode or by the oxy-acetylene process.

NOTE 1.—The rule excludes carbon-arc welding, but in special instances, where the design is approved, the carbon-arc process is permissible for the welding of flanges to tubes not less than $\frac{5}{16}$in. thick, and for the welding of dished ends to shell plates that are secured independently of the weld, and that are not less than $\frac{3}{4}$in. thick.

NOTE 2.—It is recommended, especially when the welding has been carried out by the carbon-arc or acetylene process, that fusion-welded parts should be normalised in a muffle furnace. The temperature should be maintained for a quarter of an hour after the article has been heated uniformly.

As an alternative, though less effective, where serious damage from scaling or warping would result if it were normalised, the article should be heated uniformly to a temperature of 650 deg. Cent. and then allowed to cool.

(3) *Strength of Joints.*—The rated strength of a welded joint shall at no time exceed half the strength determined by tests on reasonably well-made joints, made to similar form and subjected to similar stresses.

(4) *Material.*—The plate shall be of boiler-quality mild steel with a nominal breaking strength of 26 tons per square inch. The strength shall lie between the limits of 24 and 28 tons per square inch, but it shall be assumed that the strength of the plate when welded does not exceed 24 tons per square inch.

(5) *Plate Thickness.*—The plate of a welded vessel exceeding 12in. in diameter shall be not less than $\frac{3}{16}$in. thick.

(6) *Factor of Safety.*—The minimum factor of safety allowable on the rated strength of a welded joint shall be 4.

(7) *Hydrostatic Test.*—(*a*) The vessel shall be subjected to a hydrostatic test at not less than twice the working pressure, during which it shall be subjected to a hammer test; the pressure shall then be reduced by more than 50 per cent. of its value, after which it shall be again raised to the original value for three minutes.

(*b*) The hammer test shall consist of the plate on both sides of all welds being struck sharp vibratory blows with a hammer not less than 2 lb. in weight, the blows being struck 2in. to 3in. apart and close up to the seam. The blows shall be applied as rapidly and heavily as possible, consistent with the metal not being indented or distorted.

(*c*) When the factor of safety of the vessel exceeds 4 the test pressure shall be 50 per cent. of the bursting pressure, calculated on the rated strength of the welded joints.

(8) *Stresses Imparted by Flexible Ends.*—Where a joint or a portion of a joint, circular or longitudinal, is subjected to a bending action owing to the flexibility of an end, it shall be deemed that the strength of the joint is reduced by 10 per cent.

This shall not apply to a longitudinal seam of which the ends are reinforced in an approved manner to resist bending stresses.

(9) *Lap-welded Joints.*—(*a*) For a longitudinal seam, a lap weld with a single fillet shall at no time be permitted, and a lap weld with a double fillet shall only be permissible when neither of the plates exceeds $\frac{1}{2}$in. in thickness.

(*b*) For a circular seam or for affixing an end plate when the shell plate is not constricted, *i.e.*, turned in over the flange of the end plate, a lap-welded joint with a single fillet shall only be permitted when the thickness of the shell plate does not exceed $\frac{1}{4}$in.

(*c*) When a lap-welded joint has a double fillet, the width of the landing shall be $3t$ for a longitudinal joint, and not less than $3t$ for a circumferential joint, where t is the plate thickness, or with dissimilar plates the greater of the two thicknesses—see Fig. *k*.

(*d*) When a lap-welded joint has a double fillet the internal fillet shall be accessible for inspection. Where there is no ready means for inspection it shall be assumed that the fillet is non-existent, and accordingly for a circumferential seam the joint shall be rated as if it had a single fillet only and for a longitudinal seam it shall be prohibited.

(10) *Fillet Welds.*—(*a*) With a fillet of a lap-welded joint the surface of contact in tension shall extend over the full thickness t_2 of the plate. The surface of contact in shear shall have a width not less than t_1 and preferably not less than $1\frac{1}{4}t_1$—see Fig. *a*.

(*b*) A fillet of a lap-welded joint shall by preference have a convex profile. At no time shall the thickness at the throat be less than 0·69 times the plate thickness t_1.

NOTE.—The throat thickness is defined as the minimum depth of the weld—see Fig. *b*. Where the two contact surfaces of a fillet are equal, the rule requires that the contour shall show no appreciable concavity; a minimum throat thickness of $0{\cdot}69t$ is equivalent to the radius of the fillet being not less than $12t$, which gives an approximately straight contour, the deviation from a straight line being only $0{\cdot}02t$—see Fig. *c*.

(*c*) With a fillet weld affixing a fitting to the wall of a vessel or a pipe, the throat shall have a minimum thickness of $0{\cdot}58h$, where h is the minimum height allowable for the surface of contact in shear.

NOTE 1.—Where the two surfaces of contact of the fillet are equal, this throat thickness is attained by a fillet with a concave profile and a radius equal to $2h$, the deviation from a straight line being $0{\cdot}13t$.

NOTE 2.—The value required for the dimension h depends on the details of the design and manufacture of the joint. In general the total height for a branch tube should equal $3t$, where t is the thickness of the branch tube.

(11) *Butt-welded Joints.*—(*a*) When the diameter of the vessel does not exceed 24in., the strength of a butt joint with the plate welded at only one side shall be deemed to be reduced to half the strength of a butt joint with the plate welded at both sides. For larger diameters this form of construction shall at no time be permitted.

(*b*) When the inside surface of a butt joint is not accessible for inspection, it shall be assumed that the plate is welded at one side only.

(*c*) The edges of a plate jointed by a butt weld shall be bevelled, and the included angle of the weld metal shall be not less than 90 deg. for either a single or a double V weld.

NOTE.—It is recommended that the total depth of reinforcement at the two surfaces of the plate should be not less than 25 per cent. of the plate thickness.

(12) *Design and Attachment of Dished Ends.*—(*a*) A dished end-plate shall have an inside radius not greater than the internal diameter of the shell. The thickness of metal shall be such that the working pressure or the allowable stress to comply with rule 13 is not exceeded, but in no instance shall it be less than the thickness of the shell, and for vessels exceeding 12in. in diameter the minimum thickness shall be $\frac{1}{4}$in.

(*b*) When a dished end is flanged, the length of the flange shall be not less than $1\frac{1}{2}$in. for an end convex to the pressure, nor less than 2in. with the end concave. The minimum length of the flange shall at no time be less than four times the thickness of the plate. An increase above these specified minimum values is desirable—see Figs. *j* and *k*.

NOTE.—When a dished end is affixed by a lap joint it is recommended that the end of the shell should be constricted, and that the degree of constriction be not less than that shown by Figs. *h* and *i*.

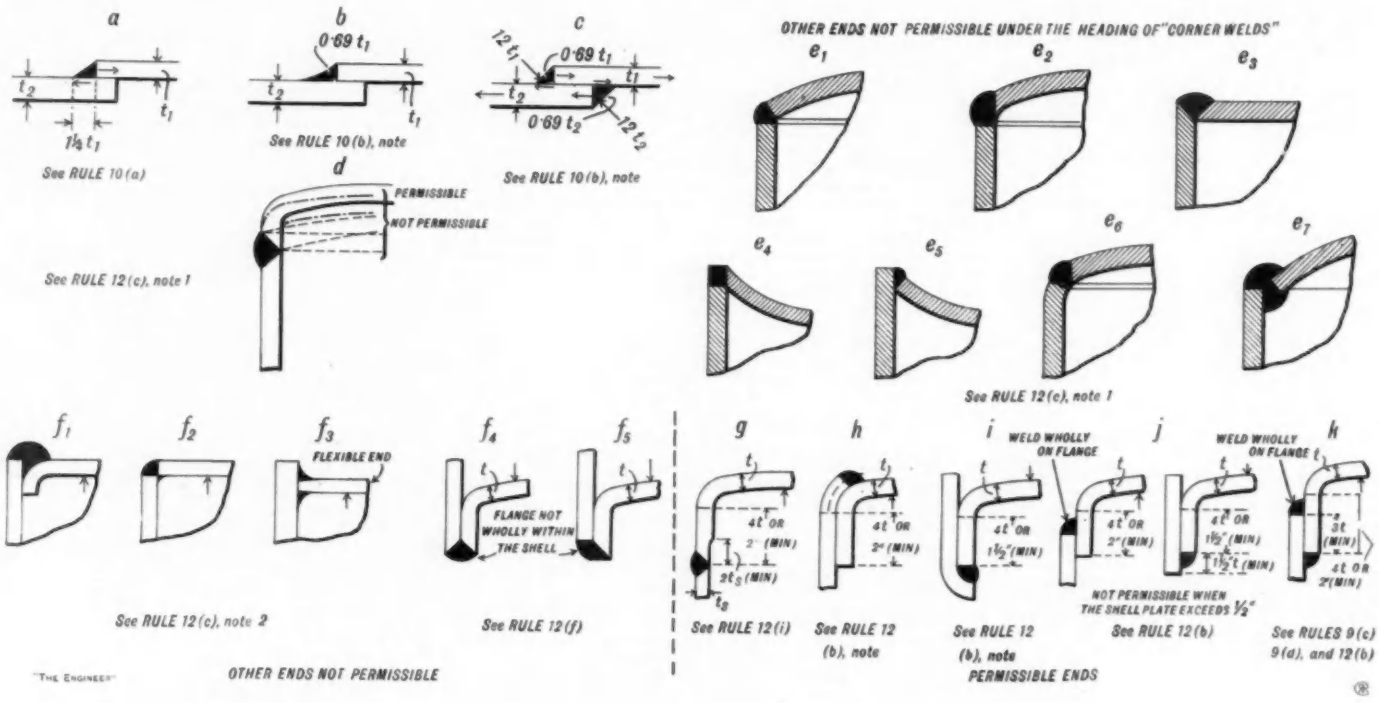
(*c*) An end shall at no time be fixed by means of a corner weld, and where a flanged end-plate is fixed by a butt joint, the flange shall form a continuous line with the shell plate.

NOTE 1.—The term "corner weld" refers to any form of weld where the flange forms an angle with the shell plate; this is illustrated by Fig. *d*. Any similar constructions without flanges, such as those shown by the drawings Fig. e_1 to e_7, are also prohibited.

NOTE 2.—Several other undesirable forms of end are constructed, *e.g.*, those shown by Fig. *f*. These are not permissible, nor is any form of flexible end the breathing of which imposes a direct bending stress on the weld.

(*d*) An end plate with reversed curvature shall at no time be permitted.

(*e*) The inside radius at a knuckle shall be not less than four times the thickness of the end plate or not less than $1\frac{1}{2}$in., whichever is the greater.



(*f*) An end plate convex to the pressure shall be driven into the shell so that the end of the flange lies a distance not less than one-and-a-half times its thickness within the shell.

(*g*) When a dished end of a thickness greater than that of the shell is affixed by a butt joint the end of the flange shall be reduced to the thickness of the shell for a length not less than twice its thickness—see Fig. *g*.

(13) *Thickness of Dished Ends.*—(*a*) With an end concave to the pressure the working stress calculated by the formula $\frac{pr}{2t}$ shall be not more than 6000 lb. per square inch, irrespective of the general factor of safety adopted for the vessel.

(*b*) With an end convex to the pressure, welded to the shell, the allowable pressure shall be not more than the bulging pressure p (calculated by Bach's formula

$$p = \frac{t}{r}\left[73{,}958 - 3272\sqrt{\frac{r}{t}}\right]$$

divided by a nominal factor of safety against bulging that is 25 per cent. higher than the desired factor of safety, the value of which is named in the following table.

In the event of r/t having a value lower than that given in the last column of the table, the thickness of the end shall be such that the stress calculated by the formula $\frac{pr}{2t}$ shall be not more than 5000 lb. per square inch, irrespective of the general factor of safety adopted for the vessel.

Designed factor of safety of vessel.	Nominal factor of safety against bulging to be used for a welded vessel with Bach's formula.	Lowest value of r/t with which the working pressure shall be determined from Bach's formula.
4·0	5·0	53·6
4·5	5·625	29·3
5·0	6·25	12·3

* From Mr. L. W. Schuster's paper "The Strength and Design of Fusion-welds for Unfired Pressure Vessels."—Institution of Mechanical Engineers, March 7th.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Early Improvement Anticipated.

INDICATIONS are that producers of iron and steel in the Midlands and Staffordshire are more eager to dispose of their products than consumers are at date to make purchases. Users of iron and steel cannot be persuaded to place forward business, and they buy no more than will suffice for their immediate needs. While in the main industries of the area there is still no perceptible increase in activity, the disposition among industrialists to anticipate an early improvement tends to extend. The heavy trades are quiet almost without exception, and something in the nature of a general betterment must be awaited before they will experience any appreciable benefit. Nevertheless, the further lowering of the Bank rate, and the advent of spring, with other minor factors, may combine to bring about some revitalisation of demand in the near future. The stand which is being made by producers against depreciation of prices is all to the good, tending, as it does, to encourage confidence.

Pig Iron.

Consumers of pig iron continue to agitate for lower prices, but blast-furnacemen firmly refuse to make concessions. Users adhere to their policy of buying only for immediate needs, being convinced that they have nothing to gain by buying forward. Further, they appear to be holding back as long as possible specifications against existing contracts. There are, however, a larger number of small orders passing than was the case before iron prices were re-declared. Some of the furnacemen dependent upon the general foundry and forge trade for the disposal of their output are becoming somewhat worried as to the future, and some stocking of material is reported. Other furnacemen who are linked up with pipe foundries manifest no concern as to the apathy of the market. Notwithstanding reports to the contrary, smelters deny that stocks threaten any curtailment of output. Consumers say the Pig Iron Producers' Association during the coming weeks will be tested as to its ability to hold together in a weakening market. It is suggested in some quarters that without control of output control of prices will not be possible and the Association so far has nothing to do with the regulation of production. Smelters for their part have faith in the recovery of the market before any serious position arises. At present they are holding their ground without wavering, demanding £3 18s. 6d. for Derbyshire No. 3 foundry iron and £3 15s. for Northamptonshire, delivered at Black Country works. This week forgemen and foundrymen have pointed out to pig iron makers that suitable coke for the furnaces can now be bought round 16s., at ovens, whereas at the beginning of the year prices ranged from 17s. 6d. up to 18s. 6d. This, they assert, entitles them to claim that some of the benefit should be passed on to them. The furnacemen reply that as they are now smelting with coke which was bought before the decline, it is premature to ask them to meet the market on the score of reduced cost of production.

Finished Iron.

Conditions in the Staffordshire finished iron trade show no change either for better or worse, and there being no perceptible increase in activity in the main consuming industries in this area the prospects of improved business in the immediate future are not very good. Mills are running irregularly, those engaged in the production of marked bars being best employed. There is no bulk of orders on the books in any of the departments, and as new business is slower to come in than old orders are being completed, the situation is tending to become worse. Ironmasters have not, however, given way to despair, for they feel the decrying of trade will not improve matters. Neither do they consider that any re-invigoration of demand would follow a lowering of selling prices, consequently they continue to quote marked bars at £12 10s., Crown quality at £10 10s., and nut and bolt and fencing bars at £9 2s. 6d. upwards. Competition in the Crown and common bar branches continues very keen, and while makers of the former are able to secure a certain amount of business against their competitors from other districts, makers of common bars are practically helpless against Belgian competitors. Wrought iron tube strip is in fairly good request at £11 2s. 6d. per ton.

Steel.

The steel trade proceeds leisurely and mills generally experience some difficulty in continuing their regular rolling programmes. In practically all branches of the finished steel trade consumptive requirements are below normal for the time of the year. Buying is of a hand-to-mouth character and steel masters find it arduous to persuade engineers to specify for building and other steels. Prices remain unchanged and but little interest was displayed in Birmingham this week in this branch of the market. There has been no change in continental prices during the past week. Small steel bars cost about £6 9s. delivered, as compared with £8 for re-rolled material at local works. The English billet makers want £6 2s. 6d. upwards for soft 2in. billets, and foreign exporters deliver such steel for £5 12s. upwards. Steel strip from the Continent costs £6 17s. 6d. to £7 delivered.

Galvanised Sheets.

Galvanised sheet makers state this week that the concerted action recently taken to stabilise prices has resulted in an improvement in trade and that some useful orders, alike on home and foreign account, have been booked at the new rate. The market tone in this department is accordingly brighter and manufacturers are more hopeful of the future. Galvanised corrugated sheets of 24-gauge are quoted firm at the agreed figure of £11 17s. 6d., while under the revised scale of extras for lighter gauges 26-gauge shows a reduction of 5s. per ton and 28-gauge a reduction of 2s. 6d. per ton. Spelter continues cheap and easy to obtain, but mills using imported sheet bars are having to pay some 2s. per ton more for them than recently.

Scrap Prices.

The scrap market is extremely dull and Birmingham merchants find themselves compelled to sell at cheaper rates. It was said on 'Change in Birmingham to-day that heavy steel scrap could be bought at anything from £3 to £3 6s. per ton delivered to South Wales and at round about £2 15s. delivered at Staffordshire works. Midland consuming works as well as those in South Wales are less active and stocks at the works are being reduced very slowly.

Cannock Chase Coalfield.

For the fourth successive month colliery owners in the Cannock Chase and Pelsall coalfield have been able to produce coal at a profit. The ascertainment figures show that in January there was a profit of 1s. 6·79d. per ton on the coal raised in the area.

Warwickshire Miners' Wages.

Warwickshire miners' wages for March are increased 2 per cent. The ascertainment shows that the industry in this area can pay on a 49 per cent. basis, as compared with a 47 basis for the last ascertainment.

Railway Contract.

The Shrewsbury firm of Sentinel Waggon Works, Ltd., has received from the London, Midland and Scottish Railway Company an order for a "Sentinel-Cammell" rail car of a type similar to those now working on the London and North-Eastern railways. The car, it is understood, is intended for the Axholme Joint Railway, which is owned by the L.M.S. and L.N.E.R. companies.

Birmingham Exchange.

The report of the committee of the Birmingham Exchange presented to the fiftieth annual meeting to-day —Thursday—states that subscriptions and entrance fees amounted to £5187, and other income £1977 7s. 9d., making a total of £8067 1s. 5d. Ordinary expenditure amounted to £5649 10s. 8d. Compared with 1928, receipts show a decrease of £241 12s. 4d., which is due entirely to a decrease in subscripton income. The surplus on the year's work is £474 11s., less than in the previous year. The committee appointed Mr. H. Bertram Hingley president, Mr. A. E. Bond vice-president, and re-appointed Mr. G. H. Pearson treasurer for the year. It also appointed Messrs. H. M. Crankshaw, O. F. Grazebrook and C. E. Hickman to fill vacancies on the committee. The members of the committee who retire are Mr. A. E. Bond, Major Lees, Mr. G. H. Pearson and Colonel Trinham. All are eligible and offer themselves for re-election.

Unemployment.

Industry in the Midlands continues to lose momentum, and the number of idle workers grows apace. There are now in the area well over 200,000 unemployed, including 72,000 temporary unemployed. The past week has witnessed an advance of 4454 in the number of persons signing the unemployment registers at Midland exchanges. In the Birmingham area itself the numbers were swelled last week by over 1000. The total of workless in Birmingham is now 30,802. At Coventry, a town at which normally the chief industries should now be approaching their busiest period, there are over 5000 persons without employment, and the number is steadily growing. It should be pointed out that this is a high figure and compares with a normal unemployed figure of 9000 in the peak of the "off" season. In several of the Black Country towns slight decreases are recorded this week, but in the aggregate they do not amount to much, being more than swallowed up by the increase in one of the larger towns. Of the grand total for the Midlands of 200,949, no less than 139,915 are male adults.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The Engineering Outlook.

THE position of the Lancashire engineering trades is reviewed by the Manchester Chamber of Commerce in the course of a general industrial survey in the following terms: Some of the principal sections of the engineering trade have been well employed of late. This applies most noticeably to the electrical section, in which at least one highly important order has been received, but the demand experienced for both light and heavy machine tools indicates that a good many are busy on a variety of work. Some of the tool makers are stated to have difficulty in coping with all the orders that come to them. Heavy oil engines are also wanted, and motor vehicle makers have placed numerous orders with repetition foundries. Textile machinists are still largely dependent upon foreign orders, which are not sufficient, but hopes are entertained that cotton trade reorganisation will make trade livelier before long. Meanwhile, loom makers state that their branch has lately been worse than it was before. Makers of artificial silk machinery, however, have had a fair amount of work.

Straightening the Mersey.

An important scheme in connection with the river Mersey for the prevention of erosion has just been adopted by representatives of the Lancashire and Cheshire County Councils and of the various local authorities directly concerned. In the past, considerable damage and inconvenience have been caused by flooding in districts, both in and just outside the Manchester area. The essential part of the scheme adopted provides by means of by-passes for the straightening of the course of the river at a total cost which is estimated at about £150,000. The matter is regarded as one of extreme urgency, and application for financial assistance is to be made to the Unemployment Grants Committee of the Government.

Order Book Additions.

The Fylde Water Board has awarded a contract for the reinforced steelwork for a water tower at Warbreck, Blackpool, to Joseph Parks and Sons, of Wadebrook Steel Works, Northwich. The water tower, it is said, will be the highest and largest in the country, and the selection of reinforced steelwork for its construction follows upon the use of it by the same authority for six bridges and two reservoirs. The Vulcan Motor and Engineering Company, Ltd., of Southport, has just secured an order from Northampton Corporation for twenty-eight motor omnibus chassis and bodies.

Industrial Results.

A final dividend on the ordinary share capital of 10 per cent., making a total of 15 per cent. for the twelve months, has just been declared by the directors of British Insulated Cables, Ltd., of Prescot. This is the same as a year ago, although in 1928 bonus shares were issued. A second interim dividend of 3½ per cent. has been declared by the directors of Ward and Goldstone, Ltd., electrical engineers, of Pendleton, near Manchester.

Non-ferrous Metals.

Apart from copper, which has registered a certain amount of recovery after the steady decline of recent weeks, further weakness has occurred since last report in all sections of the market for non-ferrous metals. At the moment of writing, tin is somewhat above the lowest point registered during the past week, but in spite of this there has been a fall on balance of nearly £3 a ton, the current price of cash metal at round £164 per ton comparing with £186 less than three months ago, and well over £210 at the beginning of last August. Buying of the metal for industrial consumption has been on moderate lines, although the low prices ruling continue to attract a fair amount of attention from speculators. Buyers in the copper section are strongly inclined to exercise caution, in view of recent fluctuations. At the moment the position of standard copper appears to be a little steadier than it has been during the greater part of the week, but, even so, the net recovery compared with a week ago is rather less than £2 in the case of cash, with values of forward metal a shade lower, if anything. Heavy selling offers of lead have more than counterbalanced the demand in this section of the market, and in consequence prices have suffered a further severe setback. Talk of output curtailment is prominent, but so far, as with tin and other metals, it has been without the desired effect, from the point of view of producers, on market prices. Spelter continues to touch new low records. Buying interest in the metal cannot be described as more than moderate, and at the moment the plentiful supplies on offer seem to be all against any decided improvement in selling prices.

Iron and Steel.

The much-needed improvement in forward buying in the foundry iron market seems to be as far away as ever, for sales this week have been on a restricted scale, and, moreover, foundries are specifying for rather less material than they were a month or so ago. Values, however, are without alteration, Staffordshire and Derbyshire makes being quoted at 77s. per ton, with Scottish brands at about 95s., and hematite iron at 92s., including delivery in each case to consumers in the Manchester district. Sales of manufactured iron are restricted, and for the most part buyers are not venturing far forward. Lancashire Crown bars are maintained at £10 15s. and No. 2 quality at £9 15s. per ton. Slackness among structural engineers is reflected in the poor calls that are being made for material against old commitments, whilst new bookings in this branch locally are reported by rollers to have been very small indeed. Boilermakers are doing little in the way of steel buying, with electrical, locomotive, and certain speciality branches perhaps the brightest patches in an otherwise exceptionally dull market. So far as values are concerned, however, these are all fully maintained at late levels. Slightly more buying has been reported this week in the continental section of the market although it has not been on an important scale. Here and there merchants who are favourably bought are in a position to shade prices a little bit; generally speaking, quotations are steady at the advances recently put into force.

BARROW-IN-FURNESS.

Hematite.

It is now possible to gauge the condition of the hematite pig iron trade a little better. The market is not bright, and there are not many orders about, but for the present, and for a month or two to come, makers are fairly well situated, as a result of orders placed some time ago for forward delivery. Makers are not in a very good position as regards cost, and there are few at present who have any margin on iron produced from their furnaces. There may be a few who are actually producing at a loss. The possible stoppage of the steel works is likely to affect the local demand very considerably in the early future. Business with both America and the Continent continues, and there were shipments from Barrow to both last week. Local ore is in fair demand, but the outlook is not so good, and the same remark applies to foreign ore. Good stocks of the latter are held locally, owing to heavy imports recently. The steel trade is dull, and it is feared that the Barrow rail mills will stop at the end of this week, unless fresh orders come to hand. The rail mill is not without orders, but they are not heavy, neither are they needed yet a while, so it is possible that the mills will stop until further orders are secured. The hoop mills will continue, as they are more favourably circumstanced as regards orders, which are mostly on overseas account.

SHEFFIELD.

(From our own Correspondent.)

Figures of Steel Production.

STATISTICS of steel production in this district during January are just to hand, and they show that in both the Sheffield and North Lincolnshire areas there was an advance as compared with December. In Sheffield and its neighbourhood the output reached 105,500 tons, which was an increase of 28,000 tons on December, but of only 2000 tons on January, 1929. Included in the total were 45,700 tons of acid and 51,400 tons of basic steel. In Lincolnshire the production rose from 57,400 tons in December and 51,200 tons in January, 1929, to no less than 73,400 tons in January this year. The quantity of pig iron produced in Lincolnshire in January was 73,200 tons—mostly basic—as compared with 72,000 tons in December and 66,000 tons in January last year.

The Present Position.

When the figures for February come to be published, they may show that Lincolnshire has maintained its position, but whether the same will prove true of Sheffield is not so certain. While new bookings in Lincolnshire have fallen away to some extent, there are sufficient orders on hand to keep the plants employed almost up to capacity for some considerable time. In Sheffield, however, there has been a falling off for some weeks, which still continues. The shrinking tendency of both forward business and inquiries is so noticeable that producers of crude heavy steel are becoming anxious about the future. While a good number of orders are coming forward, they are mostly for small quantities, and are not sufficient to take the place of earlier contracts as these are executed. Unless buying on a bulk scale is resumed within a few weeks, several large open-hearth plants will find themselves in a critical position, and will probably have to curtail output. The demand for acid steel shows no improvement, but remains much below the normal level. There is not much railway work on hand, and a further flow of orders for axles, tires and springs would be greatly welcomed. Trade in steel sheets is bad at Sheffield, as at all the centres. Business in iron and steel materials is very slow, but no changes have taken place in prices. The demand for foundry pig iron has been poor since last November, and the consumption at the foundries is at a very low level. The market for ferro-alloys used in steel making is weak, with prices on the easy side.

The Special Trades.

The special branches of the steel trade which cater for the requirements of particular industries are still doing well, though not so well as they have been. The most noticeable falling off concerns those departments which are associated with the building of automobiles and which supply castings, forgings and pressings, and also alloy steel for gears and valves. The uncertainty with regard to the McKenna duties is still causing automobile manufacturers to abstain from placing orders on their customary spring scale. The demand for stainless, non-corrodible and heat-resisting steels has shown some signs of easing, but trade is still very good, and there is such a bulk of business in hand that leading firms are in arrear with deliveries. The chemical firms were the largest buyers of these steels last year, great quantities having been used in the construction of chemical plant and apparatus. Although there is a lull at the moment it is considered certain that the trade in stainless and kindred materials will make further progress this year. There is a good demand for steel goods required in the electrical industry, and also for cold-wrought steel and strip, although the latter department is not as busy as it was a year ago.

Cutlery and Plate.

In the cutlery and plate trades there is a good deal of quietude. Signs of an Easter revival are lacking, and the current turnover is a good deal below that of the corresponding month of last year. The returns of goods dispatched to the oversea markets show, in most cases, a decline. Trade with the ordinary distributing houses in this country is poor, travellers' reports being anything but satisfactory. The cheap bazaars, which took great quantities of goods for the Christmas trade, have been ordering on a much smaller scale since. Trade in scissors keeps up very well and there is a steady business in best quality pen and pocket cutlery.

A North African Order.

The refractories department of General Refractories, Ltd., Sheffield, has secured in the face of severe foreign competition the order for the refractory linings of some zinc reduction furnaces which are to be erected at Tunis. The value of the order is stated to be about £5000.

Some Profits and Dividends.

Hadfields Ltd. has just issued its report for the year 1929. It shows that the profits were slightly higher than those of the previous year, amounting to £112,992, as against £112,053. The dividend is 2½ per cent., less tax, as before, and £92,295 is carried forward. The directors state that the general slackening of trade and increase of competition, to which attention was drawn in the last report, continued throughout the year 1929. Every effort, however, is being made to extend the market for the new and improved qualities of steel which the company has been, and still is, developing. In the case of John Baker and Bessemer, Ltd., makers of railway materials, of Rotherham, the dividend is to be 4 per cent., less tax, as compared with 5 per cent. a year ago. Last year, of course, the firm was John Baker only, the amalgamation with Bessemers having been in operation since July last. The Hoffmann Manufacturing Company, Ltd., the makers of ball bearings, which is controlled by Brown Bayley's Steel Works, Ltd., Sheffield, reports a profit for 1929 of £92,218, which is a small falling off from the £96,994 of the previous year. The dividend is maintained at 10 per cent., free of tax.

Motor Bus with Heavy-Oil Engine.

The application of the heavy-oil engine to public motor buses is new in this country and Sheffield Corporation is doing pioneer work of a most interesting kind in deciding to introduce it. A six-wheel, single-decker bus, accommodating 35 passengers, has been converted from petrol to heavy-oil engine motive power, and has given such satisfaction on its trials that buses so equipped are to be put on the 18½-mile route from Sheffield to Doncaster, with further developments in prospect. The Mercedes-Benz engine on the trial bus is the first of its type to be applied to a motor bus in this country. The fuel oil used has such a high flash point that fire risk in bus or garage scarcely exists. The price is only one-third that of what the Sheffield Corporation pays for its petrol—4¼d. per gallon, as compared with 1s. 0¾d.—and the consumption is approximately only half that of a petrol engine, the running distance being 10 miles to the gallon against 5. The fuel cost of a heavy-oil engine bus, therefore, works out at something under ¼d. per mile, as compared with 2¼d. Nothing can be said at present with regard to capital cost. The conversion has been carried out at the instigation of Mr. W. H. Goddard, A.M.I. Mech. E., of Leeds, with the sanction of the Sheffield Omnibus Committee, and the co-operation of Mr. A. R. Fearnley, M. Inst. A.E., general manager of the Sheffield Corporation tramways and motor buses. The detailed work of the conversion has been effected by British Mercedes-Benz Ltd., Davies-street, London, W. 1, which arranged for the mounting of the engine unit, complete with a Mercedes-Benz radiator, in the existing sub-frame of the Karrier six-wheeled chassis.

An Ironworks Purchase.

It is announced that Thos. W. Ward, Ltd., of Sheffield, have acquired the undertaking of the Denby Iron and Coal Company, Ltd., near Derby, which was registered in 1890 with a capital of £30,000, afterwards increased to £100,000. The plant includes four blast-furnaces, colliery and brickworks. The blast-furnaces each had a capacity of 350 tons per week. The intentions of the purchasers are not yet known, and the fate of the works is in the balance, but hope is expressed in the neighbourhood that the plant will not be totally dismantled, as several hundred men were employed by the Denby Company. In the past Messrs. Ward have always been sympathetic to workmen in similar circumstances and have generally refrained from dismantling until there was no possible hope of restarting the works which they had purchased.

NORTH OF ENGLAND.

(From our own Correspondent.)

More Work for Shipyards.

A FURTHER stimulus has been given to the shipbuilding industry on the North-East Coast by the placing of orders for four new motor tankers, each of 11,500 tons deadweight, with Tyneside shipbuilders by the Anglo-Saxon Petroleum Company, Ltd., of London. The successful firms are Swan, Hunter and Wigham Richardson, Ltd., Wallsend-on-Tyne, and Hawthorn, Leslie and Co., Ltd., of Hebburn-on-Tyne. Each vessel is to have a twin-screw set of single-acting Werkspoor engines, fitted with the Werkspoor supercharging system and of sufficient power to give a speed of 12½ knots. The vessels are to cost about £180,000 each. Hawthorn, Leslie and Co. are building at present three vessels of much smaller capacity for the same owners. With the exception of about half a dozen destroyers and a large floating whale oil factory, Tyne shipyards at present are almost exclusively engaged on tanker construction, the majority of the vessels being for Norwegian owners. Ship-repairing on the North-East Coast is not so active just now, and inquiries have fallen off. Firms, however, still have a fair amount of work in hand.

Cleveland Pig Iron.

The position in the Cleveland pig iron trade shows little change on the week. Whilst there has been some improvement in the shipments of pig iron from the Tees, particularly to Scotland, the volume of business is still very small, and traders are anxiously scanning the industrial horizon for some indication of the development of a healthy spring demand. Fears are expressed that this may be delayed until the fate of the Coal Bill, and the terms of the Budget are disclosed. Meanwhile, business is chiefly confined to small parcels for early delivery, and forward contracts are unobtainable. Output is rather excessive, but merchants have not much iron to offer, and ironmasters continue to quote 75s. for No. 1 quality, 72s. 6d. for No. 3 G.M.B., 71s. 6d. for No. 4 foundry, and 71s. for No. 4 forge.

Hematite Pig Iron.

Producers of East Coast hematite pig iron are anxious to book orders for early delivery, and merchants are keen to unload their still substantial holdings. A little home business is passing, but overseas trade is virtually at a standstill, as continental makers are substantially underselling the iron of this district. For some time East Coast makers have been unable to command anything like remunerative prices, and a further downward tendency is causing anxiety. Home sales are only on a very moderate scale. No difficulty is experienced in placing orders for mixed numbers at 77s., and rather lower terms are stated to have been accepted.

Ironmaking Materials.

Business in foreign ore is practically at a standstill. Ironmasters are well stocked, and in some cases are delaying deliveries under running contracts. The nominal quotation for best Rubio ore is 22s. c.i.f. Tees. Good medium blast-furnace coke is now no more than 20s. 6d. delivered at the works.

Manufactured Iron and Steel.

Continued absence of business in the manufactured iron and steel trade is causing much uneasiness. Works are not so fully employed as was expected earlier in the year, and it is feared that more steel furnaces will have to be closed down shortly. Several rolling mills in the Tees-side district are running on short time. In one or two departments orders for early delivery are needed, and in all branches new forward contracts would be welcome. Demand for semi-finished steel is only moderate. Most descriptions of heavy steel are slow of sale, but manufacturers have fairly good order books. Manufactured iron and steel prices are not quotably altered.

The Coal Trade.

Without showing any particular strength, there is a much better tendency in the Northern coal trade. The steam coal section has shown some animation during the past few days, mainly attributable to the eagerness of merchants to tender for some of the Scandinavian business now on offer. The main feature is that tonnage has been definitely stemmed for next week, which indicates that the full working output will be cleared. Best Northumberland steams show a good tendency, and values are rather firmer at 15s. 3d. by direct sellers. Tyne primes are a better market, and fitters report a good prospective tonnage supply. Values show a steadier tone at 14s. 6d. for large and 12s. for small, but the latter combined with proportionate orders for large might be discounted. There has been a steady booking up of coking unscreened coal, and prices have certainly hardened a few coppers. Supplies are very well taken up, and from 14s. 3d. to 14s. 6d. is now the general quotation. Best grade bunker coals are fully sold, and command 15s. 6d. to 16s. 3d. for any further supplies available. Seconds are consequently reacting to the steadier tone, and 14s. 3d. to 14s. 6d. is quoted for good ordinary descriptions. The prompt position for gas coal producers is a little better than of late, but there are still considerable quantities for all March, and no special new business is circulating. Best qualities are quiet at 16s. 6d. Secondary gas coals are in good supply, but just a shade steadier at 14s. 3d. to 14s. 6d. There is a good demand for bunker coal for vessels' use at the various shipping ports, but the demand for cargoes from the coaling stations is much below expectations. Prices, however, are easily maintained, and buyers are not able to force any pronounced concessions. Good average qualities are held at 14s. 3d., and for superiors at from 15s. to 16s. The demand for gas coke remains slow, and, despite limited stocks, prices are weakly held at 21s. to 22s. Patent oven coke is abundant, and in slow demand at an easy value of 18s. to 19s. Beehive and foundry cokes are also neglected, and are quoted nominally at 26s. to 29s.

SCOTLAND.

(From our own Correspondent.)

Outlook Unchanged.

INDUSTRIAL conditions are on the whole unchanged, and prospects generally are still rather obscur. In most departments problems of reconstruction are either being tackled now or arrangements are being made to do so in order to deal with a situation which threatens to become chronic, despite all previous efforts towards improvement. The operation of the "Derating Bill" may provide a certain amount of relief, but even then it seems evident that industry has too big a burden to carry. The rationalisation movement is too new to throw any light on the subject, but this latest method will be watched with great interest. If burdens can be so reduced or adequately apportioned, no doubt much will be done to enable producers to offer cheaper goods, and perhaps thereby to become competitors in the true sense. Meanwhile, in most departments interest is difficult to maintain in view of the small demands.

Steel.

Makers of heavy steel have a fairly steady output, but could easily tackle a much larger flow of orders. Tube makers have nothing fresh to report, business being comparatively quiet in all sections, and it is apparent that the effects of the Tube Cartel's arrangements have not yet been fully experienced in this area. Conditions at the sheet works vary considerably, some being irregularly and some steadily employed. The general tone is better, however, since the price cutting of galvanised sheets has ceased. It is understood that the latest development in this respect has been the establishment by agreement of £11 17s. 6d. as the minimum f.o.b. value for 24 gauge corrugated sheets.

Iron.

Steel re-rollers are very quiet, and bar iron makers continue to experience a very lean time. Re-rolled steel bars are quoted about £7 12s. 6d. per ton home or export, and bar iron is unchanged at £10 5s. home and £9 15s. per ton export. Four pig iron furnaces damped down at the end of the year have not been restarted, and the total number in blast in Scotland does not exceed twenty-seven. A quiet turnover at the fixed prices is reported.

Scrap.

Supplies of scrap are fairly generous at the moment, and consumers are not over-eager to take deliveries just now. Prices therefore are easy, with heavy steel at 65s.; heavy basic, 62s. 6d.; and cast iron machinery, 69s. 3d. per ton.

Coal.

In spite of easier prices and lower freights, the export trade remains dull. The tonnage required for

early shipment is very restricted, owing to the difficulty experienced by importers abroad in disposing of stocks which were accumulated as a precautionary measure in view of the shortage which occurred last year. Furthermore, there is very little forward business mentioned, owing partly to the fact that foreigners will not buy ahead unless at current prices, a provision which exporters cannot concede in view of the uncertainty existing at present. Importers abroad, too, are endeavouring to induce shippers to cancel some contracts, while at the same time the collieries are pressing exporters to provide orders against contracts. Practically all classes of fuel require fresh orders, the exception being Lanarkshire splints and navigation fuels. Prices are not thoroughly tested, but the tendency is easier. Aggregate shipments amounted to 231,423 tons, against 229,857 tons in the preceding week and 254,079 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

CONDITIONS in the anthracite coal trade continue to be very steady, but the same cannot be said of steam coals, which are very unevenly placed from the point of view of immediate orders, though, so far as prices are concerned, are practically all on the minima. Work at the pits is irregular, as may be imagined when it is pointed out that at the end of last week the number of idle tipping appliances at the various docks rose to 37. Arrivals over the week-end only improved the situation to the extent of reducing idle tips to 17, with six steamers waiting to berth. One favourable factor which may influence the position during the near future is the fact that the chartering of tonnage last week displayed an expansion and was over 300,000 tons, but it is difficult to say when this will come along. Some of the tonnage taken up will in all probability not be ready for loading until the extreme end of this month, or early April. There is, naturally, a disposition on the part of merchants to charter tonnage as far ahead as possible for definite commitments, in view of the fact that rates of freight are more likely to advance than remain at their existing level, which is quite uneconomic. Unfortunately, prompt orders for cargoes of steam coals are comparatively few in number. The foreign coaling stations show very little activity, as so much tonnage is laid up. Those firms which are closely associated with the export trade to France find that the demand has fallen away to such an extent that there is very little need to go outside for tonnage, as most of them have steamers chartered on voyages over the best part of this year. Business for Spain is negligible and is detrimentally affected by the unsettled conditions prevailing in that country and the instability of the peseta value. It will be readily seen that altogether, with mild weather conditions adversely influencing coal consumption generally, the export trade can scarcely display the briskness that is desired. Nevertheless, it is surprising that the weekly shipments keep up so well. In market circles it is possible to hear members expressing curiosity as to whether the coalowners are likely to reduce the scale of minimum prices. Unsatisfactory as trade is, it would be unwise for buyers to place much if any expectation, in that course being adopted, because it is very doubtful whether it would influence any fresh orders. On the contrary, it would, in all probability, have the effect of encouraging possible buyers to hold off all the more. Additional orders, though not heavy, have recently been concluded for South America, and it is satisfactory to find that the Portuguese State Railways have now bought altogether 100,000 tons of small coals for delivery during the next three months. Other inquiries on the market are for 25,000 tons of large coal for the Sudan Railways for delivery July to September, while the Woolwich Ordnance Factory has asked for prices for 13,000 tons of low volatile coal peas for delivery over six months, or, alternatively, 30,000 tons over twelve months.

Shipping.

The conditions prevailing in the shipping industry continue to claim as much attention as ever, for the reason that they are so deplorable, no matter what branch one looks at. At the end of last week, it appeared as if outward rates of freight for the Mediterranean had a hardening tendency, but this improvement has temporarily faded out, and there are no definite signs of improvement in any direction, while as regards homeward business this is equally unsatisfactory. The bulk of the tonnage operating must be doing so at a loss. The lack of any real indication of recovery in rates is all the more remarkable when it is borne in mind that the number of vessels laid up is in the neighbourhood of 400, with an aggregate carrying capacity of two and a quarter million tons.

"Boxing" Coal.

Reference was made last week to the dispute with the Newport coal trimmers on the question of the refusal to fall into line with the other ports in respect to the boxing of coal in order to minimise breakage. The employing interests immediately took up a strong attitude, and at a meeting of the Joint Control Trimming Board, which, by the way, was not attended by the men's representatives, they decided that if the workmen did not agree by the 10th inst. to do what boxing was required in any future shipments the owners would take whatever steps they considered necessary to have the work carried out to their satisfaction. The result was that there was another meeting of the Newport coal trimmers last week-end and they agreed to adopt the practice prevailing at the other ports and box a "reasonable" quantity of coal as from Monday last.

Docks Traffic.

The Great Western Railway Company's returns of sea-borne traffic at the six ports in this district which are under its control show that for the four weeks ended February 16th the total of imports and exports was 3,197,874 tons, as compared with 2,588,982 tons for the corresponding period of 1929. Taking the returns for the whole of this year to February 16th, the aggregate of imports and export reached the figure of 5,376,922 tons, made up of imports 667,501 tons and exports 4,709,421 tons, which compares with a total for the corresponding period of last year of 4,690,293 tons, made up of imports 635,582 tons and exports 4,054,711 tons.

Current Business.

The tone of the steam coal market all round is very quiet. All branches are without feature, except that minimum prices prevail in respect of practically all qualities. Even small coals have lost their steadiness and superior descriptions are obtainable round about 13s. 6d., while sized nuts of dry quality are down to about 24s. The market is extremely irregular, which reflects the uneven working of the collieries. Patent fuel makers are comparatively well off for the moment, but coke is easier. Pitwood has shown an improving tendency as the result of reduced supplies coming forward, and the market is about 26s. to 26s. 6d.

SMOKE PROBLEMS.

A PAPER entitled "Some Factors Affecting the Problem of Smoke Prevention," which was read by Prof. W. E. Gibbs at the meeting of the Institute of Fuel on Wednesday, March 12th, was concerned particularly with the turbid flue gases that result from the combustion of coal. The author stated that smoke may be defined as a disperse system in which a solid is dispersed in an extremely finely divided condition in a gas, and pointed out that industrial smoke generally contains particles varying in size. These particles are all very much denser than the gas in which they are suspended, and, therefore, tend to settle from the gas by gravitation. Settling is retarded by the viscosity of the gas, which increases with rising temperature. The gas itself is generally in turbulent motion along a horizontal or vertical duct of large dimensions, and it is unlikely that under such conditions, any but very coarse particles will be removed by settling. It is necessary, therefore, to devise special arrangements for catching and removing the particles. These devices operate with a limited efficiency, so that a considerable portion of the suspended material escapes into the atmosphere.

The author dealt at length with the character and formation of smoke under the headings of: Condensation processes; dispersion processes; coal smoke; concentration of coal smoke, &c. Tables were given showing the percentages of particles of given size in gases with powdered fuel firing, and with various fuels when using chain grate stokers, and it was shown that smoke consists of a relatively small number of widely scattered, large particles, surrounded by a host of smaller particles, the number of which increases rapidly as their size diminishes, but otherwise is proportional to their concentration. The larger particles may be removed by settling or centrifugal force, but they do not appear to carry any large proportion of the smaller particles with them. The problem of smoke prevention is largely bound up with the problem of bringing about the flocculation of these very fine particles to form larger aggregates which can be removed along with the large particles. Gravity separation, precipitation by centrifugal force, smoke washing, flocculation, electrostatic precipitation, were all referred to, but the author stated that it would seem that the cyclone type of separator provided the most satisfactory method of removing finely divided solid matter from large volumes of smoke. At present, the efficiency of a cyclone separator is limited, because so much of the solid matter is too finely divided to be precipitated by this means. It is, however, conceivable that, by investigating the properties of coal smoke, it may be possible to devise simple methods for flocculating the finer particles, so that a much greater proportion of the solid matter may then be removed by centrifugal separation.

LAUNCHES AND TRIAL TRIPS.

BLINJOE, passenger and cargo steamer; built by "De Maas" Shipbuilding Company; to the order of the Royal Packet Company; dimensions, length 252ft., breadth 40ft., depth 15ft. 5in.; to carry 1290 tons deadweight. Engines, four-cylinder Lentz, 1000 I.H.P.; trial trip, February 15th.

CONTESSA, steam ship; built by Barclay, Curle and Co., Ltd., to the order of Vaccaro Bros.; dimensions, length 397ft., breadth 53ft. 6in., depth 33ft. Engines, inverted four-crank quadruple-expansion, 25½in., 37in., 54½in., 78in. by 48in. stroke, pressure 260 lb. per square inch; constructed by the builders; launch, February 18th.

VEERHAVEN, steam ship; built by Wm. Gray and Co., Ltd., to the order of N.V. Gebr Van Uden's Scheepvaarten, Argentuur Maatschappij; dimensions, length 434ft., breadth 54ft. 3in., depth 29ft. 8½in. Engines, balanced quadruple inverted direct-acting, pressure 260 lb. per square inch; constructed by the builders; trial trip, February 21st.

TALUNE, steamship; built by Blythswood Shipbuilding Company, Ltd., to the order of Union Steamship Company; dimensions, 315ft. by 45ft. by 22ft. 3in. Engines, triple-expansion; constructed by D. and W. Henderson and Co., Ltd.; trial trip, February 24th.

HIGHLAND PRINCESS, twin-screw motor ship; built by Harland and Wolff, Ltd., to the order of H. and W. Nelson, Ltd.; dimensions, 520ft. by 69ft. by 35ft. 9in. Engines, two eight-cylinder double-acting four-cycle Harland-B. and W. type; constructed by the builders; trial trip, February 25th.

CRAFORD ELLIS, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Hav Company, of Oslo; dimensions, 290ft. by 40ft. by 25½ft.; to carry 3200 tons. Engines, triple-expansion, pressure 200 lb. per square inch; constructed by the builders; trial trip, February 26th.

CEFALU, steamship; built by Workman, Clark (1928), Ltd., to the order of Standard Fruit and Steamship Corporation; dimensions, 397ft. by 53ft. 3in. by 33ft. 3in. Engines, quadruple-expansion; constructed by the builders; launch, February 27th.

EDWARD BLYDEN, motor cargo vessel; built by Harland and Wolff, Ltd., to the order of British and African Steam Navigation Company, Ltd.; dimensions, 370ft. by 51ft. 6in. by 33ft. 6in.; gross tonnage, about 3840. Engines, single-acting eight-cylinder airless injection Harland-B. and W. type; constructed by the builders; launch, February 27th.

ANGLO SWEDE, oil tank motor ship; built by Sir W. G. Armstrong, Whitworth and Co. (Shipbuilders), Ltd., to the order of Rederiaktiebolaget Tanker; dimensions, 476ft. by 59ft. 7in.; to carry 11,300 tons. Engine, single-acting two-stroke seven-cylinder direct-reversing Polar Diesel; constructed by the Atlas Diesel Company; trial trip, February 27th and 28th.

EVINA, motor tank ship; built by Sir W. G. Armstrong, Whitworth and Co. (Shipbuilders), Ltd., to the order of Mr. H. E. Hansen Tangen; dimensions, 408ft. by 54ft. 9in. by 32ft.; to carry 8840 tons. Engines, Armstrong-Sulzer two-stroke, single-acting, six-cylinder Diesel; constructed by the builders; launch, February 28th.

MACGREGOR LAIRD, motor ship; built by David and William Henderson and Co., Ltd., to the order of African Steamship Company; dimensions, 370ft. by 54ft. by 33½ft.; to carry 5650 tons. Engines, eight-cylinder single-acting airless injection Harland-B. and W. type, 740 mm. diameter by 1500 mm. stroke; constructed by Harland and Wolff, Ltd.; launch, February 28th.

ULSTER PRINCE, motor passenger ship; built by Harland and Wolff, Ltd., to the order of Belfast Steamship Company, Ltd.; dimensions, 345ft. by 46ft. by 19ft.; gross tonnage, 3760. Engines, two ten-cylinder airless-injection trunk-type Diesel; constructed by the builders; trial trip, March 3rd.

INNISFALLEN, motor passenger ship; built by Harland and Wolff, Ltd., to the order of City of Cork Steam Packet Company, Ltd.; dimensions, 320ft. by 45ft. 6in. by 19ft.; gross tonnage, 3250. Engines, two ten-cylinder Harland-B. and W. airless-injection trunk-type Diesel; constructed by the builders; launch, March 4th.

LADY OF MANN, steamship; built by Vickers-Armstrongs, Ltd., to the order of Isle of Man Steam Packet Company, Ltd.; dimensions, 373ft. by 50ft. by 26ft. 6in. Engines, two sets of Parsons geared steam turbines, total S.H.P. 11,500; launch, March 4th.

CONTRACTS.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., Loughborough, has received from the Bath Corporation Electricity Department an order for a 7000 kW Brush-Ljungstrom turbo-alternator. This is the fifth set of Brush-Ljungstrom manufacture to be installed by the Bath Corporation since 1921.

BRITISH INSULATED CABLES, Ltd., of Prescot, has secured the contract for erecting an overhead line from Stourport to Banbury, to the order of the Shropshire, Worcestershire and Staffordshire Electric Power Company. The line is 50 miles in length, and is to consist of steel cored aluminium conductors supported on steel lattice towers. The voltage is 66,000, and the value of the work is in the neighbourhood of £110,000. The steel cored aluminium conductors will be manufactured at the company's Prescot works.

THE INSTITUTE OF TRANSPORT.—The tenth annual dinner of the Institute of Transport was held at the Hotel Cecil on Wednesday evening, when the President, Sir Josiah Stamp, was in the chair. The toast of the evening was proposed by Mr. Herbert Morrison, the Minister of Transport, and was acknowledged by the President. Sir Henry Maybury proposed "The Guests," to which toast General Dawes, the American Ambassador, should have responded; but, owing to the death of Mr. Taft, the Ambassador was not present, and Sir William Bragg and Sir Herbert Jackson spoke in his place. General Dawes hopes, however, to be present on a future similar occasion.

STUDENTS AND ENGINEERING.—A good deal has been written and discussed of late of the fitness of university trained men for commercial life, and it is gradually becoming recognised that men of this type can be made valuable assets in the country's commercial enterprises. The work of the National Union of Students in this direction is, however, little appreciated by those interested. This Union is the only organisation which links together the students in the different universities and university colleges of this country, and in turn provides the means of actual relationship with those of the Dominions and foreign countries. The activity of the Union which is of principal interest to business men is the arrangement of "faculty," or study, tours to various countries, on which groups of students can not only see the practice of their future profession in that country, but learn something of the mentality of the people of the country which they are visiting. During the seven years of the Union's existence, these tours have been arranged in engineering and fifteen other subjects. The value of this kind of instruction is self-evident, and there is no other student body which identifies itself with this work. The work of the Union is destined to play a considerable part in the Dominion development and international relationship of the future, and its importance has been recognised by grants from the universities themselves. It is at present engaged on an appeal for an Establishment Fund, to place its finances on a sound basis, which has the support of the Prince of Wales, Mr. Ramsay Macdonald, and two ex-Prime Ministers and other public men. Those interested are asked to communicate with the Appeal Secretary, the National Union of Students, 3, Endsleigh-street London, W.C. 1, for further details of the Union's work.

THE INSTITUTE OF MARINE ENGINEERS.—The thirty-fourth annual dinner of the Institute of Marine Engineers, which took place at the Connaught Rooms on Friday of last week, March 7th, was a most successful event, and over six hundred members and guests were present. The chair was taken by the President, Eng. Vice-Admiral Sir Robert Dixon, K.C.B., D.Eng. In giving the toast of "Shipbuilding and Engineering Industries," Sir George Hamilton referred to the advantages of safeguarding of our industries, while Sir Hugh Bell, in his reply, put forward a plea for individual effort and freedom from Government interference. The toast of "The Institute of Marine Engineers" was ably proposed by Sir Burton Chadwick, and in his reply Sir Robert Dixon referred to the rapid growth of the Institute since it was founded forty-one years ago. From small beginnings it had now advanced to a membership of 3170. Much of its success was, he said, directly due to the devoted service of its honorary secretary, Mr. James Adamson. It was very necessary, he thought, that the Institute should keep well ahead of the times and that it should be in a position to place before the shipowner new proposals for the propulsion of ships. In the absence of Sir Basil Kemball Cook, the toast of "H.M. Dominions Overseas and the Mercantile Marine" was proposed by Mr. A. E. Laslett, the Chief Engineer-Surveyor of the Board of Trade, who expressed the hope that Great Britain would soon be in possession of another fast Atlantic liner, which, like the "Mauretania" in her day, would enable this country to re-gain and to retain the Blue Ribbon of the Atlantic. In his reply, Sir George Warburton Fuller stressed the need for greater uniformity of law with regard to British and Colonial shipping and the value of a closer co-operation between our country and the Dominions in all matters relating to the Mercantile Marine. The toast of "The Chairman" was given by Mr. Richard W. Allen. During the evening there was a programme of music and a most enjoyable time was spent.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/6 to 21/–
(1) Spanish	21/6 to 23/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	22/–

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 1 0	—
No. 1 Foundry	4 0 6	—
No. 3 Foundry	3 18 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 17 0	3 17 0
No. 1	3 17 6	3 17 6
Cleveland—		
No. 1	3 15 0	3 15 0
Silicious Iron	3 15 0	3 15 0
No. 3 G.M.B.	3 12 6	3 12 6
No. 4 Foundry	3 11 6	3 11 6
No. 4 Forge	3 11 0	3 11 0
Mottled	3 10 6	3 10 6
White	3 10 6	3 10 6
MIDLANDS—		
(3) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 15 6	—
„ „ Foundry	3 19 6	—
(3) Northampton—		
Foundry No. 3	3 15 0	—
Forge	3 11 0	—
(1) Derbyshire—		
No. 3 Foundry	3 18 6	—
Forge	3 14 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 13 6	—
No. 4 Forge	3 9 6	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 9 6 (*a*); 4 11 6 (*b*); 4 15 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 2 6 to 9 7 6	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	12 5 0	12 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	8 5 0 to 8 7 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	10 0 0	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 10 0	—
Hoops	9 15 0 to 10 0 0	—
Soft Wire Rods	8 0 0	—
MIDLANDS—		
Small Rolled Bars	8 0 0 to 8 15 0	—
Billets and Sheet Bars	6 2 6 to 6 12 6	—
Galv. Sheets, f.o.b. L'pool	11 17 6	—
Sheets (30 W.G.)	16 7 6	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/3 to 18/6
Block Tin (Cash)	163 15 0
„ (three months)	165 15 0
Copper (cash)	69 15 0
„ (three months)	67 10 0
Spanish Lead (cash)	18 8 9
„ „ (three months)	18 15 0
Spelter (cash)	17 18 9
„ (three months)	18 10 0
MANCHESTER—	
Copper, Best Selected Ingots	77 15 0
„ Electrolytic	84 7 6
„ Strong Sheets	110 0 0
„ Tubes (Basis Price), lb.	0 1 3
Brass Tubes (Basis Price), lb.	0 1 1
„ Condenser, lb.	0 1 3
Lead, English	20 5 0
„ Foreign	18 17 6
Spelter	18 15 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/4½ per lb.	
Ferro Tungsten	3/1½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 7 6	7/–
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/–
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£33 10 0	10/–
„ „ „ 1 p.c. carbon	£38 0 0	13/6
„ „ „ 0·70 p.c. carbon	£40 10 0	15/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home; £13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 0 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS

SCOTLAND.

(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/–
„ „ Ell	15/9
„ „ Splint	16/9 to 18/–
„ „ Trebles	13/6
„ „ Doubles	12/9
„ „ Singles	12/3
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/9
„ „ Jewel	17/6
„ „ Trebles	13/9
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	12/– to 13/6
Screened Navigation	18/– to 18/6
Trebles	13/6
Doubles	12/–
Singles	12/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	13/9
Secondary Steam	13/6
Trebles	12/6
Doubles	12/3
Singles	12/–

ENGLAND.

(8) N.W. COAST—	
Steams	21/6 to 23/–
Household	38/– to 51/–
Coke	25/–
NORTHUMBERLAND—	
Best Steams	15/–
Second Steams	14/– to 14/3
Steam Smalls	11/–
Unscreened	13/–
Household	25/– to 37/–
DURHAM—	
Best Gas	16/3
Second	13/9 to 14/3
Household	25/– to 37/–
Foundry Coke	25/– to 30/–

SHEFFIELD—	Inland.
Best Hand-picked Branch	26/6 to 28/–
Derbyshire Best Bright House	21/– to 23/–
Best House Coal	20/6 to 21/6
Screened House Coal	18/6 to 20/–
„ „ Nuts	16/6 to 18/–
Yorkshire Hards	15/6 to 17/–
Derbyshire Hards	15/6 to 17/–
Rough Slacks	9/– to 10/–
Nutty Slacks	7/6 to 8/6
Smalls	3/– to 5/–
Blast-furnace Coke (Inland)	17/– on rail at ovens
Furnace and Foundry Coke (Export), f.o.b.	20/– to 21/–

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	20/–
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/9 to 19/3
Ordinary Dry Large	18/– to 18/6
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/– to 18/3
Best Eastern Valley Large	18/– to 18/3
Ordinary Eastern Valley Large	17/9 to 18/–
Best Steam Smalls	13/6 to 14/6
Ordinary Smalls	13/– to 13/6
Washed Nuts	17/6 to 24/6
No. 3 Rhondda Large	20/6 to 21/–
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	16/– to 16/6
„ „ Smalls	15/– to 15/6
Foundry Coke (Export)	32/6 to 37/–
Furnace Coke (Export)	27/– to 28/–
Patent Fuel	22/– to 22/6
Pitwood (ex ship)	26/6 to 26/9
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	36/– to 38/–
Seconds	28/6 to 32/–
Red Vein	24/– to 28/–
Machine-made Cobbles	42/6 to 45/–
Nuts	43/– to 46/–
Beans	25/– to 27/6
Peas	20/– to 20/6
Breaker Duff	10/6 to 11/–
Rubbly Culm	11/6 to 12/–
Steam Coals :	
Large	20/– to 21/–
Seconds	18/6 to 19/6
Smalls	13/6 to 15/–
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 12/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(From our Correspondent in Paris.)

Flood Prevention.

THE floods which have devastated half a dozen departments in the South of France with heavy loss of life and, at present, incalculable damage to property, are due to causes that have often provoked minor disasters, and it has remained for this unexampled catastrophe, so far as France is concerned, to show the urgent necessity of doing something to prevent their recurrence. The many small rivers from the Massif Central, as well as the Garonne, swelled with startling suddenness, one increasing its volume by no less than 135 times, while the Tarn rose 25ft., in consequence of the release of an accumulation of water on impervious soil following upon a long spell of heavy rains. At present there are two suggestions for providing a remedy, an inevitable one being afforestation, which is regarded by many as a real palliative in the sense that wooded lands hold the water, and there certainly seems to have been an increasing tendency to floods with the destruction of woods and forests. An afforestation policy has been carried out of late years, but it is far from keeping pace with the destruction. Another suggested remedy is the construction of the Canal des Deux Mers across the South of France between Narbonne and Bordeaux. This is an old scheme, primarily intended to serve strategical purposes, but the idea of the canal has long been abandoned, except by the people in the Midi, who regard it as likely to be of great value from the point of view of irrigation and the supplying of hydraulic power, and it is now suggested that the canal would serve the purpose of draining water from the Massif Central and thereby prevent serious floods. The length of the Canal des Deux Mers would be about 128 miles and its width 225ft.

Public Works.

Probably in no other country but France has there been so much activity in the carrying out of public works, first in reconstruction enterprise in the devastated areas, and, then, in the execution of a programme which aimed at a great national economical equipment, such as ports, railways, roads, inland waterways, hydro-electric power stations, which was intended to provide the country with a sound basis of industrial and commercial prosperity. What has already been done was mostly accomplished with the aid of German reparations materials, and, even then, contractors found that, with the fluctuating currency values, they had considerably underestimated their original tenders, with the result that work on many undertakings had to be suspended. Now that the State has to provide the money required to continue the programme of public works, which has been partly held up since Germany was relieved of the burden of providing material for reparations, means are being sought whereby contractors can be guaranteed against losses incurred through an appreciation of values. At present those values have not reached the level of the gold standard, and the prospect of paying higher wages in the future, and more for their raw material, is placing contractors in a very difficult position. For some years past the railway companies have accepted as a basis for estimates the hourly wage paid in the electrical engineering industry and the average cost of coal to the electrical power stations during the preceding three months. This arrangement has proved fairly satisfactory so far as wages are concerned, but coal prices have fluctuated too much to serve as a reliable basis for raw material values, and the Government, therefore, in view of the resumption of work on the programme of public undertakings, proposes to extend the number of materials to serve as indices, so that the contractor will be able to draw up his estimates with less risk of finding his calculations upset by appreciated values.

Maritime Traffic.

An indication of the country's prosperity is the steadily increasing traffic at the ports during the past two years. The number of ships entering and leaving the ports during 1929 was 125,899, as compared with 119,647 in the previous twelvemonth, and the total quantity of goods loaded and unloaded was 52,353,235 tons, an increase of 6,827,725 tons. There has always been a rivalry between Rouen and Marseilles for the premier position, and the former lost it during the crisis in the coal trade, when the heavy drop in the consignments of British coal obliged Rouen to prepare for the more extensive importation of other goods, such as timber and oils. An improvement in the British coal imports, however, brought the tonnage for 1929 up to 9,486,100 tons, representing an increase of about 2½ million tons. Marseilles followed with 9,151,181 tons, an increase of rather more than a quarter of a million tons. The comparison does not, of course, take into account the passenger traffic at Marseilles, which is considerable. Havre came next with a little less than 5½ million tons, followed by Dunkirk, Bordeaux and Nantes in that order.

Hydro-electrical Energy.

The Saint-Guillerme hydro-electric power station on the Romanche has just been put into service. This is the first stage of the programme being carried out by the Société des Forces Motrices de la Haute-Romanche, which includes the construction of the Chambon dam. It will hold up 60,000,000 cubic metres of water that will serve to regulate the river. The power station is temporarily supplied with water from about a kilometre above Chambon, but when the barrage is completed the hydraulic energy will be taken from there and another smaller power station will be erected at the foot of the dam. The Saint-Guillerme plant consists of four groups of turbo-alternators totalling 29,000 horse-power. The programme is to be completed by the construction of a third power station.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

308,205. February 18th, 1929.—SCAVENGING TWO-STROKE CYCLE INTERNAL COMBUSTION ENGINES, Fried. Krupp Germaniawerft Aktiengesellschaft, of Kiel-Gaarden, Germany.

The invention relates to two-stroke cycle internal combustion engines of the type which is provided with inlet and outlet ports for scavenging and charging current, so arranged that the scavenging and charging current is projected along a concave piston face and is deflected off the piston face along the wall of the cylinder opposite to the inlet ports, and is then reversed round the cylinder cover and escapes through the outlet ports. The object of the invention is to provide an improved arrangement of the inlet and outlet ports, which results in considerable simplification and is advantageous in connection with the

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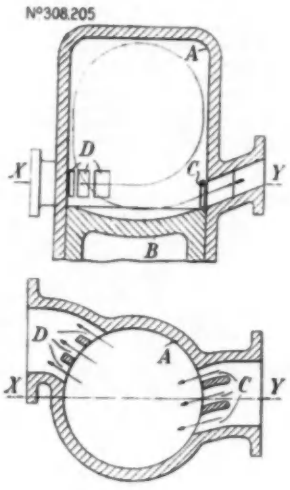

scavenging of two-stroke cycle Diesel engines. A denotes the working cylinder of the engine, fitted with a piston B having a concave surface. The inlet ports C have a direction such as to cause the scavenging current to enter tangentially to the piston end face and to flow towards the opposite cylinder wall at an acute angle relatively to the plane X–Y of the section. Somewhat above the inlet ports C the outlet ports D are arranged, and more particularly on a place of the cylinder wall which is not struck by the entering scavenging current. They are also inclined at an acute angle, with respect to the plane of section X–Y. After having passed over the piston end face, the scavenging air rises in a close current at the cylinder wall opposite the inlet ports, is reversed at the cylinder cover, and then flows toward the outlet ports, while describing in its course a spiral line.—*January 30th*, 1930.

308,305. March 6th, 1929.—THE ADMISSION OF AIR TO THE CYLINDERS OF FOUR-STROKE INTERNAL COMBUSTION ENGINES WITH AIRLESS INJECTION OF THE FUEL, Heinrich Dinner, of Ennenda (Glarus, Switzerland).

The invention relates to four-stroke internal combustion engines with airless injection of the fuel, and has for its object to provide an engine in which the fuel is efficiently admitted and ignited. The inlet valve A is arranged opposite the exhaust valve B, and the fuel valve C is mounted in the centre of the

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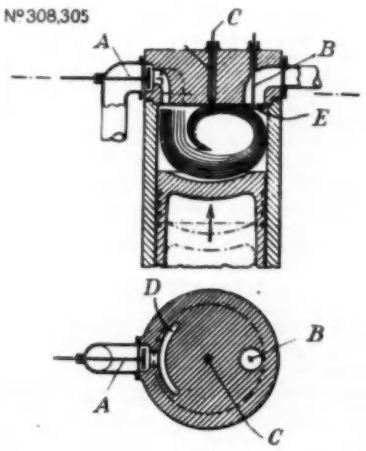

cylinder cover in the known manner. The air is caused to flow into the cylinder close to the cylinder wall in a stream of relatively narrow dimensions. This is effected by forming the inlet opening as a long and relatively narrow slit D, out of which the air flows along the wall of the cylinder. The central part of the air stream then flows over the heated head E of the exhaust valve B so that the fuel, at the moment of its injection, enters a zone of specially heated air and a rapid ignition is assured.—*January 30th*, 1930.

DYNAMOS AND MOTORS.

310,330. April 19th, 1929.—DYNAMO-ELECTRIC MACHINES, *International General Electric Company, Incorporated, of 120, Broadway, New York.*

This invention relates to squirrel-cage wound armature motors of comparatively great axial length. The construction of correspondingly long armatures for these motors involves difficulties in manufacture, more particularly if the cage-wound armatures are built as annular bodies which are subsequently inserted into previously constructed parts of the machine, as, for instance, in the so-called "built-in" type motors. These difficulties can be obviated if, in accordance with the invention, the armature is divided into two parts or, for extreme axial length,

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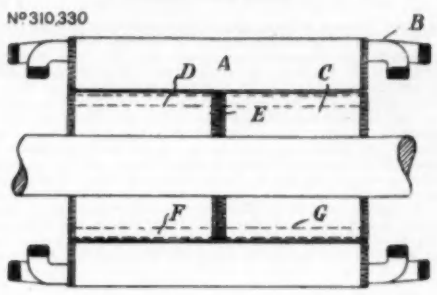

into three parts. These parts are finished singly and built in, abutting closely one against the other, care being taken that the armatures are not in electrical connection with each other. In the construction shown the stator is indicated at A and has a winding B. The rotor comprises two armatures C and D separate from one another and each having at its ends short-circuit rings E. The bars F and G of the two armatures are not connected with each other.—*January 30th*, 1930.

TRANSFORMERS AND CONVERTERS.

306,039. February 13th, 1929.—ELECTRICAL TRANSFORMER COOLING TANKS, *Associated Electrical Industries, Ltd., of Bush House, Aldwych, Westminster.*

This invention relates to electrical transformer cooling tanks, and comprises an arrangement for applying a cooling medium to the heat radiating units traversed by the insulating liquid enveloping the transformer. The air supply devices comprise individual units A mounted on each radiator, through which an insulating liquid passes, such as oil. Each of the devices A is provided with a fan B and an electric motor for driving the fan. The motor may be started and stopped either manually or automatically. A suitable arrangement for controlling the motor comprises a temperature responsive thermal relay mounted

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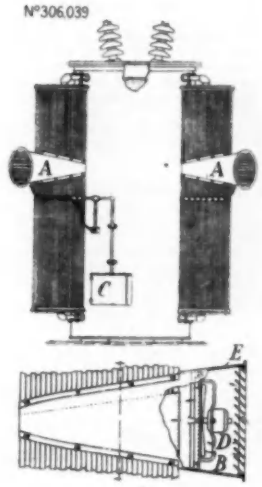

within a casing C. The temperature responsive relay operates to close automatically an electric circuit to start the fan motor when the temperature of the liquid medium within the transformer tank reaches a predetermined value. A deflector structure D may be provided in the outer end of the casing E, which permits the entrance of air but deflects rain. The fan B draws cool air from the atmosphere through the opening between the deflectors D and forces it through openings into the space between the radiator tubes. The air currents from each side meet at an angle and form a resultant current of air that moves upwardly over the tubes of the radiator. This action tends to decrease the temperature of the surfaces of the radiator tubes, which, in turn, results in a cooling of the liquid medium flowing through the tubes in the usual manner.—*January 30th*, 1930.

309,926. April 17th, 1929.—ELECTRIC TRANSFORMERS, *International General Electric Company, Incorporated, of 120, Broadway, New York, U.S.A.*

In order to reduce the height of three-phase transformers, it is common practice to provide five legs, the first and last of which are without windings. According to this invention, every core

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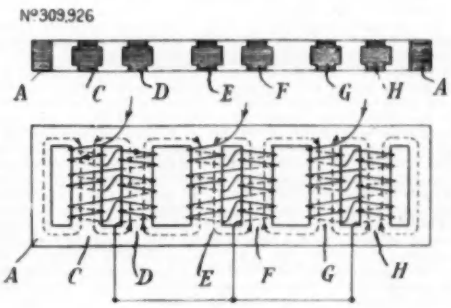


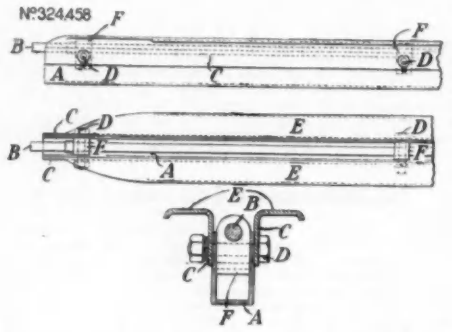
that receives a winding is subdivided into two or more separate cores, with a cross section that permits circular coils to be employed. The legs without windings are shown at A, whilst the legs C and D carry the windings of the first phase, E and F those of the second phase, and G and H those of the third phase. The windings of each pair of legs belonging to one phase may be

connected in series or parallel, but in such a way that the fluxes in neighbouring legs are oppositely directed. The height of the yoke can thus be kept very low. The windings are shown connected in series in such a manner that no high pressure difference can occur between neighbouring points of the legs of a phase.—*January 30th*, 1930.

LOCOMOTIVES.

324,458. November 20th, 1928.—Bow Trolley for Electric Vehicles, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C. 2; and Frederick Morris, of 32, Mulgrave-avenue, Ashton-on-Ribble, Lancashire.

This invention relates to bow trolleys for electric locomotives, &c., and is more particularly concerned with the provision of renewable wearing strips for the collector. As usually constructed, the fixing bolts for the renewable wearing surface are exposed to wear when the collector itself wears, and it is an object of the invention to obviate this. Another object is to provide increased stiffness for the bow, whereby bending due to pressure on the trolley wire or to blows on the suspension ears is eliminated. A bow constructed according to the invention consists of a length of channel section material A pivotally suspended from and parallel to a cross bar B at the top of the trolley framework.

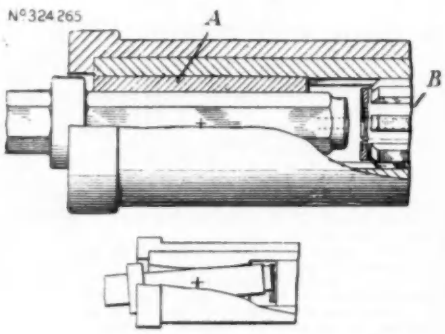


The renewable wearing collector strips consist of a pair of lengths of inverted L section C bolted one to each side of the channel by means of bolts D which pass through and hold both collector strips simultaneously. The horizontal arms of the L's are turned outwardly away from the channel and present upwardly a flat collector surface E towards the trolley wire. The fixing bolts are thus well below this surface and are never subject to contact with the conductor. To take the compression of the fixing bolts distance pieces F are arranged between the channel walls, and each distance piece may be in the form of a block which is bored to receive the cross bar B, thereby acting at the same time as the pivotal suspension means for the channel. The centre of gravity of the whole device may be arranged below the suspension point on the cross bar B so that the wearing surfaces E remain horizontal and upwardly turned whenever the trolley is not in contact with the conductor.—*January 30th*, 1930.

MACHINE TOOLS AND SHOP APPLIANCES.

324,265. February 19th, 1929.—Hammer Rock Drills, L. Pryce, Corner House, Commissioner-street, Johannesburg.

The inventor points out that with hammer rock drills the chuck A tends to wear, in service, as shown in the smaller sketch, so that the drill is not held truly axially. In such circumstances



the blows of the hammer B tend to broom over the end of the drill steel on account of the local effect of the blow. As a consequence, the inventor makes the faces of the hammer and the drill shank spherical, with a radius equal to half the length of the chuck.—*January 23rd*, 1930.

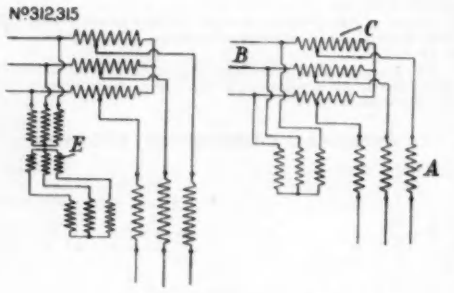
MISCELLANEOUS.

294,549. July 25th, 1928.—Apparatus for the Limitation of High Short-circuit Electric Currents, Kurt Küppers, of 4, Burgfeldstrasse, Wilhelmshöhe, Cassel, Germany.

The inventor proposes to limit short-circuit currents by the direct connection into the circuit to be protected of one or more ohmic resistances of iron or of a metal having an increase of resistance for a rise of temperature similar to that of iron. The resistances are of such dimensions that under normal working conditions they remain at low temperature, but when subjected to the short-circuit currents become heated in an extremely short time and their resistance is multiplied sufficiently to secure the required limitation of the short-circuit currents. The drop in the voltage under normal working conditions amounts to only a fractional part of the drop in the voltage caused by choking coils giving a similar protective effect. Deterioration of the power factor under normal working conditions is avoided, and the power factor in the case of a short circuit is, owing to the preponderance of the ohmic resistance, considerably higher than when reactance coils are used. The inventor also explains that the cost is much lower and less space is occupied than is the case with choking coils having the same protective effect.—*January 27th*, 1930.

312,315. May 7th, 1929.—Induction Regulator Installations, Maschinenfabrik Oerlikon, of Oerlikon, near Zürich, Switzerland.

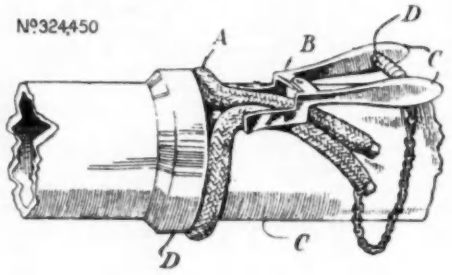
This invention relates to an induction regulator installation with an auto-transformer in which only that winding of the induction regulator which furnishes the auxiliary voltage is connected to the auto-transformer, whilst the exciting winding of the induction regulator is energised by the network voltage. From the right-hand diagram it will be seen that only that portion of the induction regulator A which furnishes auxiliary voltage is connected to the auto-transformer, while the exciting winding of the induction regulator is applied direct to the lines B. In this case the auto-transformer C should be designed merely



for an output equal to the maximum consumption output, minus the internal capacity of the induction regulator, and the wattless component of magnetisation. In high-tension networks, especially in the case of small outputs, the exciting portion of the induction regulator is preferably fed with low voltage through a transformer E, as illustrated in the left-hand diagram. —*January 30th*, 1930.

324,450. November 16th, 1928.—A Device for Use in Connection with the Pouring of Lead into the Joints of Pipes, John Oliver, of West View, Killingworth-road, Forest Hall, Northumberland.

The mould comprises a length of asbestos rope A having its ends suitably finished to prevent fraying, and a spring clip B for holding the ends of the mould together after wrapping around the spigot end of the pipe C which is inserted in the faucet



D of an adjacent pipe. The spring clip B may comprise a pair of similar jaws pivoted together, each jaw being shaped to engage the mould in such a manner as to avoid all risk of fraying. Extensions C are formed on the jaws, and between the extensions there is a compression spring D which tends to force the jaws together, the extensions being raised or offset from the jaws to allow the clip to be readily gripped between the thumb and fingers.—*January 30th*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institute of Metals: Sheffield Local Section.—In the Non-Ferrous Section of the Applied Science Department of the University, St. George's-square. "Electric Heat Treatment Furnaces," by Mr. A. Glynne Lobley. 7.30 p.m.

Institution of Engineering Inspection.—Royal Society of Arts, John-street, Adelphi, W.C. 2. "Deep Well Pumps," by Mr. J. J. O'Neal. 5.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "An Outline of Siemens No. 50 Telephone Switching Equipment," by Mr. W. A. Sallis. 7.30 p.m.

Royal Aeronautical Society and Royal Meteorological Society.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. "The Aims and Objects of the Aeroarctic," by Professor Fridtjof Nansen. 6.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "New Light on Vision," by Professor G. Elliot Smith, F.R.S. 9 p.m.

Town Planning Institute.—Caxton Hall, Caxton-street, S.W. 1. "Town Planning and the Man in the Street," by Captain B. S. Townroe. 6 p.m.

SATURDAY, MARCH 15TH.

Institution of Automobile Engineers: London Graduates.—Visit to the works of Vauxhall Motors, Luton. 2.30 p.m.

MONDAY, MARCH 17TH.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. "Combustion in Diesel Engines," by Mr. H. R. Ricardo. 7.30 p.m.

Institution of Mechanical Engineers: Graduates' Section.—Storey's-gate, S.W. 1. "Science in Works Management," by Mr. W. Taylor. 7 p.m.

King's College Engineering Society.—King's College, London, W.C. 2. "Haulage in Coal Mines," by Mr. W. H. Dormer. 5.15 p.m.

TUESDAY, MARCH 18TH.

Institute of Metals: Birmingham Local Section.—In the Chamber of Commerce, New-street, Birmingham. "Nickel-chromium Alloys," by Mr. W. R. Barclay. 7 p.m.

Institute of Metals: North-East Coast Local Section.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Annual general meeting, short paper competition. 7.30 p.m.

Institution of Automobile Engineers: Coventry Graduates.—Broadgate Café, Coventry. "Front Wheel Drive," by Mr. N. Bland. 7.15 p.m.

WEDNESDAY, MARCH 19TH.

Institution of Automobile Engineers.—Metropole Hotel, King-street, Leeds. "Organisation of Public Service Motor Vehicle Repair and Maintenance Systems," by Mr. W. Lewis Morgan. 7.15 p.m.

Institution of Locomotive Engineers: Birmingham Centre.—Birmingham Chamber of Commerce, New-street, Birmingham. "Mineral Oils and Lubrication," by Mr. Walter Kay. 7.15 p.m.

Overhead Lines Association.—The Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. "Comparative Costs of Overhead and Underground Transmission Lines," by Dr. Eckstrom. 5.30 p.m.

Royal Meteorological Society.—49, Cromwell-road, South Kensington, S.W. "Meteorology and Water Supply," by Dr. H. Lapworth. 7.30 p.m.

THURSDAY, MARCH 20TH.

Association of Ex-Siemens' Men.—Gatti's Restaurant, King William-street, W.C. 2. Annual dinner.

Institution of Automobile Engineers.—Joint meeting with the Institution of Production Engineers, 83, Pall Mall, S.W. 1. "The Influence of Monetary Policy on Production," by Mr. R. G. Hawtry. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, W.C. 2. "The Medical and Surgical Applications of Electricity," by Dr. B. Leggett. 6 p.m.

Institution of Mechanical Engineers: North-Western Branch.—Engineers' Club, Manchester. "Operating Results with the Recent Extension of Barton Power Station," by Mr. H. L. Guy and Mr. H. C. Lamb. 7.15 p.m.

Junior Institution of Engineers.—Visit to the works of the Royal Sovereign Pencil Company, Ltd., Neasden.

King's College Engineering Society.—King's College, London, W.C. 2. "Motoring: Its Progress in the Last Thirty Years," by Mr. S. B. Thomas. 5.15 p.m.

FRIDAY, MARCH 21ST.

Diesel Engine Users Association.—Caxton Hall, Westminster, S.W. 1. "The High-speed Diesel Engine," by Mr. H. R. Ricardo. 3.30 p.m.

Institution of Electrical Engineers: North-Eastern Students' Section.—Armstrong College, Newcastle-on-Tyne. "A Survey of Switch and Control Arrangements with Examples of Modern Practice," by Messrs. J. Bennett and O. A. Chrisp. 7.15 p.m.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. "The Design and Results of a 600 lb. per Square Inch Boiler Installation," by Mr. W. Nithsdale. 6 p.m.

Institution of Municipal and County Engineers: West Midland District.—Visit to the Messrs. Tarslag (1923), Ltd.'s, works and the Earl of Dudley's Round Oak Ironworks. Assemble at 2 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "Surface Combustion," by Mr. M. V. Hurst. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-upon-Tyne. "Direct Flooding Calculations," by Sir Westcott Abell. 6 p.m.

SATURDAY, MARCH 22ND.

Institution of Electrical Engineers: North Midland Students' Section.—Visit to the Yorkshire Copper Works at Stourton, Leeds. 2.30 p.m.

Institution of Municipal and County Engineers: North-Western and Yorkshire Districts.—Town Hall, Halifax. "Borough and County Borough Extensions in the Light of the Local Government Act, 1929," by Mr. F. Marsden.

MONDAY, MARCH 24TH.

King's College Engineering Society.—King's College, London, W.C. 2. Anniversary meeting. "A Brief Review of Mechanical Engineering Progress in the Past Thirty-four Years," by Brig.-Gen. Magnus Mowat. 5.30 p.m.

TUESDAY, MARCH 25TH.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Discussion, "Tyne Bridge, Newcastle," by Mr. David Anderson; "The New Wearmouth Bridge, Sunderland," by Mr. Geoffrey Lancaster Groves. 6 p.m.

Sheffield Metallurgical Association.—198, West-street, Sheffield. "Common Defects in Steel for Gear Manufacture," by Mr. F. W. Rowe. 7.30 p.m.

WEDNESDAY, MARCH 26TH.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Students' Meeting. "Nomography as Applied to Engineering," by Mr. Philip John Pollock. 6.30 p.m.

Newcomen Society.—Prince Henry's Room, 17, Fleet-street, E.C. 4. "Winding Engines of Richard Trevithick," by Mr. A. Titley. 5.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Bastian Meter Company, Ltd., of Slough, ask us to announce that Mr. S. A. Williams, associate, A.I.E.E., has joined its engineering staff.

Messrs. Lotz and Kier, of Stoke-on-Trent, ask us to announce that they have opened a London office at 36, Victoria-street, and have appointed Mr. R. V. Chate, A.M. Inst. C.E., as their manager there.

Mr. M. O. Blakey, who has for ten years been connected with the Texas Corporation in India and Ceylon, has been appointed local manager of Anglo-Cuban Asphalt and Bitumen, Ltd., for those countries and is proceeding to India to take up his duties immediately.

Fawcett, Preston and Co., Ltd., of Phœnix Foundry, Liverpool, ask us to announce that the address of their London office has been changed from 70, Victoria-street, S.W. 1, to 21, Old Queen-street, Westminster, S.W. 1. Their telephone number remains unaltered, viz., Victoria 1712.

Institution of Automobile Engineers.—At the annual meeting of the Institution of Automobile Engineers, held prior to the general meeting on March 4th, it was announced that Sir Herbert Austin would be President for the forthcoming session, the Vice-presidents being Mr. C. R. F. Engelbach, Mr. L. H. Pomeroy, Mr. W. J. Tennant and Mr. W. A. Tookey. The summer visit of the Institution will this year be held on Thursday, June 26th, to Saturday, June 28th, inclusive. The members will proceed down the Thames by launch, visiting places of interest on the way, and will make their headquarters at Tilbury, whence excursions will be made.